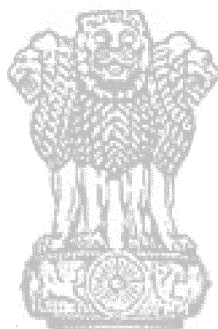


REPORT  
ON  
ECONOMIES IN  
CONSTRUCTION COSTS



PLANNING COMMISSION  
(Construction Division)  
NEW DELHI

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## PREFACE

0.1. Construction programmes are inter-woven in a large measure in all sectors of development, be it housing, transport, industry, irrigation power, agriculture, education, or health.

0.2. Some of the prevailing methods are outmoded, some designs are over-burdened with safety factors, and there are other design criteria which in the light of newer techniques and methodologies, could be rationalised. There is scope for higher productivity in the manufacture of building materials and also for the introduction and promotion of some new materials. There is also considerable room for improvement in the organizational and administrative side dealing with the whole field of construction finance, credit systems, organisation and administrative procedures of public works departments, types of contracts and methods of accounting and payment.

0.3. Since the Fourth and successive Plans will carry sizable component of construction, economies in construction costs will be of significance in relieving the strain on Nation's resources and in assisting large development programmes. To advise on this subject the Planning Commission set up a high level technical Panel vide their Resolution No. PC/Constn/Plan/6/3/65 dated 1st October 1965. The Panel was constituted as under :

*Chairman*

**Prof. M. S. Thacker, Member, Planning Commission**

Maj. Gen. Harkirat Singh, Adviser (Construction), Planning Commission.

Shri M. R. Chopra, Chairman, Central Water & Power Commission.

Maj. Gen. K. N. Dubey, Engineer-in-Chief, Army Headquarters, New Delhi.

Shri N. G. Dewan, Chief Engineer, Central Public Works Department, New Delhi.

Shri H. P. Sinha, Director General (Road Development), Ministry of Transport.

Shri D. N. Chopra, Addl. Member (Works), Ministry of Railways (Railway Board).

A Senior Chief Engineer, to be nominated by the Govt. of Uttar Pradesh.

A Senior Chief Engineer, to be nominated by the Govt. of Punjab.  
 A Senior Chief Engineer, to be nominated by the Govt. of West Bengal

A Senior Chief Engineer, to be nominated by the Govt. of Assam.

A Senior Chief Engineer, to be nominated by the Govt. of Maharashtra.

A Senior Chief Engineer, to be nominated by the Govt. of Andhra Pradesh.

A Senior Chief Engineer, to be nominated by the Govt. of Mysore.

A Senior Chief Engineer, to be nominated by the Govt. of Madras.

Shri Y. G. Patel, President, Builders' Association of India, Bombay.

Shri P. L. Verma, M/S Steelcrete India Ltd., New Delhi.

Shri H. J. Shah, M/S Shah Construction Co. Ltd., Bombay

Shri Uttam Singh Dugal, C/o M/S H. S. Dugal & Co. Ltd., New Delhi.

Shri S. Kumar, Chairman, National Projects Construction Corporation Ltd., New Delhi.

Shri S. Krishna Iyer, Chairman, Southern Centre, Builders' Association of India, Madras.

Shri Akshoy Bose, C/o M/S Ballardie Thomson & Mathews, Calcutta.

Shri P. C. Kapoor, Director General, Directorate General of Technical Development, New Delhi.

Dr. Lal C. Verman, Director, Indian Standards Institution, New Delhi.

Shri C. B. Patel, Director, National Buildings Organisation, Ministry of Works, Housing & Supply, New Delhi.

Prof. Dinesh Mohan, Director, Central Building Research Institute, Roorkee.

Prof. S. R. Mehra, Director, Central Road Research Institute, New Delhi.

Prof. G. S. Ramaswamy, Director, Structural Engineering Research Centre, Roorkee.

Shri G. Pandey, Vice-Chancellor, University of Roorkee, Roorkee.

Prof. R. N. Dogra, Director, Indian Institute of Technology, New Delhi.

Brig. S. K. Bose, Director, Indian Institute of Technology, Powai, Bombay.

The President, Institution of Engineers (India) or his representative.

The President, Indian Institute of Architect or his representative.

The President, Institute of Town Planners or his representative.

The President, Institution of Surveyors or his representative.

The President, Indian Roads Congress or his representative.

Shri A. N. Malhotra, Director (Construction Services) Planning Commission—*Member Secretary*.

The names of officers nominated by the various State Governments and Institutions as their representatives on the Panel are given below :

Govt. of Uttar Pradesh—Shri P. S. Bhatnagar, Chief Engineer, P.W.D., Lucknow.

Govt. of Punjab—Shri Kulbir Singh, Chief Engineer, Chandigarh Project, Chandigarh.

Govt. of West Bengal—Shri J. K. Banerjee, Consulting Engineer, P.W.D., Calcutta.

Govt. of Assam—Shri K. Barua, Chief Engineer, P.W.D., Shillong.

Govt. of Maharashtra—Shri K. V. Joglekar, Chief Engineer & Jt. Secretary, Buildings & Communication Department, Bombay (Shri D. K. Datey replaced Shri Joglekar in December 1966).

Govt. of Andhra Pradesh—Shri P. T. Malla Reddy, Chief Engineer, Major Irrigation & General, Hyderabad.

Govt. of Madras—Shri J. C. Abraham, Chief Engineer (Central), Madras.

Govt. of Mysore—Shri I. M. Gugdum, Chief Engineer, P.W.D., Mysore.

Institute of Engineers (India)—Shri K. K. Nambiar, Chief Engineer, Concrete Association of India, Bombay.

Indian Institute of Architects—Shri J. R. Bhalla, Vice-President.

Institution of Surveyors—Shri P. N. Gadi, President.

Institute of Town Planners—Shri J. K. Chowdhury, President (later replaced by Shri P. C. Khanna, the new President).

Indian Roads Congress—Shri Hukum Singh, Secretary.

0.4. The terms of reference of this Panel of Experts were :

*"To advise on guide-lines for economy in construction costs and to periodically review the progress made in this field."*

0.5. The Chairman who had the authority to co-opt additional members on the Panel coopted the following :

Shri Jamshed Burjor Aga, C/o M/S Shapoorji N. Chandabhoj & Co. Chartered Architects, Engineers & Surveyors, Bombay.

Shri K. M. Kantawala, Chief Engineer (R&B) and Joint Secretary to the Govt. of Gujarat, Ahmedabad.

Shri D. Dutt, Managing Director, National Buildings Construction Corporation Ltd., New Delhi.

Shri S. K. Joglekar, Chief Architect, Central Public Works Department, New Delhi.

Maj. Gen. R. A. Loomba, Director General, Border Roads, New Delhi.

Shri T. N. Subba Rao, C/o M/S Gammon India Ltd., Bombay.

Shri Erach A. Nadirshah, Consulting Chartered Engineer, Bombay.

Shri M. N. Dastur, C/o M/S M. N. Dastur & Co., Consulting Engineers, Calcutta.

The Panel also benefited from the opinions of the following who participated in the deliberations as special invitees :

Shri W. X. Mascarenhas, C/o M/S Mascarenhas, Taraporewala, Consulting Engineers, Bombay.

Shri N. S. Gupchup, Chief Engineer, Hindustan Construction Co. Ltd., Bombay.

Shri C. L. Handa, Member (D&R), Central Water & Power Commission, New Delhi.

Shri A. R. Venkataraman, Member (I&P) Central Water & Power Commission, New Delhi.

Dr. P. S. Lokanathan, Chairman, National Productivity Council, New Delhi.

Brig. K. Pennathur, Executive Director, National Productivity Council, New Delhi.

0.6. During the absence of Shri N. G. Dewan on leave, Shri B. K. Guha acted as a Member of the Panel in Shri Dewan's place. Later Shri Dewan retired from service and Shri B. K. Guha, who took over as Chief Engineer, Central P.W.D. replaced him. Shri A. N. Malhotra, Director (Construction Services) and Member-Secretary of the Panel reverted to Government of Haryana and Shri P. N. Gadi, Senior Specialist (Construction) Planning Commission, took over as Member-Secretary in addition to being a representative of the Institution of Surveyors.

0.7. At the first meeting of the Panel held on 6th December 1965, a detailed working paper on various aspects of planning, construction, administration, etc. which had earlier been circulated among the members, was discussed at length. It was decided to analyse the subject under eight sub-heads and a sub-committee to deal with each of the sub-heads was constituted. The sub-committees were to study the following aspects and to submit their reports to the Panel for discussion in a subsequent meeting :

(a) Pre-planning.

(b) Designs, specifications, consultancy practices and National Building Code,

- (c) Materials,
- (d) Finance, Contracts, etc.
- (e) Administrative Reforms of Public Works Administration,
- (f) Quality control, cost control and supervision,
- (g) Construction plant and machinery,
- (h) Motivation, training and publicity.

0.8. These sub-committees held several meetings and submitted their reports which were edited in the Planning Commission for discussion by the Panel. A brief summary of these reports was also prepared. The Panel which discussed these reports in a meeting on 28th June 1966 was of the unanimous opinion that there was a vast scope for achieving economy if recommendations of the sub-committees were implemented.

0.9. As cost of materials accounts for about 60% to 70% of the total cost of any construction, it was decided that development and productivity in the building materials industries should receive special attention.

0.10. Building materials cover a wide field including well organised industries like those for production of steel, cement, pipes, sanitary fittings, asbestos sheets, and also not-so-well organised industries like those for manufacture of bricks & tiles, quarried materials, lime & surkhi and timber products. In order to study the industries in the latter category and also the effects on construction costs of transactions in the fields of construction finance, credit facilities, and of administrative & contract procedures, etc. five Study Groups representing manufacturers, engineers, builders, architects, scientists, etc. both from the public sector and the private sector were set up to study productivity in the timber industry, lime industry, brick & tile industry, quarrying of sand, ballast and crushed metal. In the meetings of the Study Groups various difficulties being faced by the materials industries and measures necessary to increase productivity were brought out.

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0.11. The Panel and the Study Groups were dissolved by the Planning Commission during November 1967. Although this is not a report of the Panel mentioned above, the recommendations embodied in it are based largely on the conclusions arrived at in the Sub-committees and Study Groups and on the discussions of the Panel.

0.12. In October 1966 the Minister of Works, Housing & Urban Development convened a conference of eminent technologists to discuss the subject of economies in construction costs. After a general discussion, a Committee was formed with Maj. Gen. Harkirat Singh as a convenor to evolve detailed recommendations which, if implemented, would result in effecting economy. For this purpose the committee adopted as the basis the list of important points which had earlier emerged as a result of the discussions of the Panel of Experts and of the Study Groups, and made suitable recommendations. These recommendations were then discussed in another session of the conference and approved. A copy thereof is at Appendix-A. These recommendations were submitted to the Minister for further action.

0.13. In February 1967, the National Buildings Organisation arranged a seminar on 'Productivity in Building Industry.' Another seminar on

'Construction Costs' was arranged by the same organisation in August 1967. These two seminars afforded an opportunity for discussing with technologists who took part in these seminars several recommendations of the Panel of Experts. The recommendations which emerged as a result of the discussions in the seminars were on the same lines as the recommendations of the Panel referred to earlier. These were forwarded by the N.B.O. to the Ministry of Works, Housing & Supply and to other Construction Agencies. The recommendations made by the Panel of Experts for effecting economy in construction costs are, therefore, considered to reflect the opinion of a large section of technologists engaged in the field of construction in the country.

0.14. Simultaneously with the writing of this report; steps have been taken to initiate action on some of the important recommendations of the Panel. The progress so far made in this direction has been brought out in the ensuing paragraphs.

0.15. **Building Materials Assessment and Development Cells.**—Surveys were conducted with the help of the National Buildings Organisation in the States of Uttar Pradesh, Madhya Pradesh, Rajasthan & Gujarat to assess construction components of various sectors of economy as provided for in their Fourth Five Year Plans. A paper was prepared and forwarded to States bringing out the advantages of long term materials planning and the setting up of Building Materials Assessment & Development Cells in States. Methodology to assess construction components of different sectors of economy and norms to assess requirements of construction materials based on outlays in construction were incorporated in this paper. This recommendation, when implemented, should have a marked influence on stabilising prices of local building materials.

0.16. **Construction Finance Corporation.**—The importance of evolving short-term and long-term measures to extend financial assistance on reasonable terms to the construction industry with a view to reducing construction costs has been highlighted by the Panel. A paper on the suggested short-term measures and the long-term measures of setting up of a Construction Finance Corporation by Government has been prepared in consultation with representatives of the construction industry and some financial institutions. The paper is under consideration with the Planning Commission and a copy thereof has been forwarded to the Ministry of Finance as desired by them.

0.17. **National Building Code.**—Preparation of a National Building Code laying down structural and other provisions designed to protect the safety of the public and covering other requirements related to buildings including choice of materials, building practices, etc. has been recommended by the Panel. The Panel, has further recommended that this document should be so framed as to be conveniently adopted or enacted for use by different Departments, Municipal Administrations and Public Bodies. A paper bringing out the importance and composition of this Code was prepared and forwarded to the Indian Standards Institution as that organisation was considered to be the most appropriate one for undertaking this task. Work on preparation of the Code has already been taken in hand by the I.S.I. which has also set up a Guiding Committee for the purpose. As the Guiding Committee consists of representatives of Construction Agencies, Research Institutions, Municipal Corporations, etc. the implementation of the Code when completed, will be facilitated.

**0.18. All India Standard Schedule of Rates.**—After studying the present Schedules of Rates which vary from Department to Department and contain wide variations in description of similar items, in units adopted, in methods of measurement and in basic data adopted in preparation of rates, etc. the Panel has come to the conclusion that an All India Standard Schedule of Rates suitably priced on a zonal or other basis is essential. This will enable contractors to refer to one schedule only when working for different Departments in the same locality. A paper on the subject laying down details of the proposed Standard Schedule was prepared and sent to the National Buildings Organisation as it is considered that the N.B.O. is most suited to take up this work. The matter is under consideration with the Standing Committee of the N.B.O.

**0.19. Standard Contract Forms.**—The Panel have recommended preparation of Standard Contract Forms to make conditions of contracts equitable to contracting parties to eliminate an undue share of risk of unforeseen conditions which is at present borne by contractors, to expedite payments, to prevent undue locking of contractors capital, etc. so that works are executed smoothly and economically. This work was taken up by a committee set up by the Planning Commission. This committee comprised representatives of all interests associated with execution of works. A Standard Contract Form for use by Government Departments and Public Sector Undertakings has been prepared and circulated.

**0.20. Construction Equipment Pools.**—To reduce idle time and to minimise under-utilisation of expensive construction plant and machinery, the Panel have recommended setting up of Equipment Pools on commercial lines and on a zonal basis so that machinery is maintained on scientific lines and is operated by properly trained operators. The third Lok Sabha Committee on Public Undertakings had also expressed similar views in their eighth report on "Townships and Factory Buildings of Public Undertakings" dated May 1965. A detailed paper on the subject was prepared and forwarded to the Ministry of Works, Housing & Supply with a recommendation that a suitable Equipment Pool be set up for Delhi zone on an experimental basis. The question of setting up of Pools in other zones could be examined after studying the performance of the proposed Pool in Delhi and remedying any flaws which may be noticed.

**0.21. Reorganisation of the National Buildings Organisation.**—The Panel have recommended that the National Buildings Organisation should, in addition to the functions which are being performed by it at present, address itself to several other important tasks. For that purpose its expansion and conversion into an autonomous organisation has been recommended. A detailed paper on the subject has been prepared and forwarded to the Secretary, Ministry of Works, Housing & Supply for necessary action.

**0.22. Central Ministry of Construction.**—The system of Public Works Administration has been studied in the past by many committees. The Building Projects Team of the Committee on Plan Projects dealt with this subject in detail in their report in 1962. Taking into consideration this report, the reports of the Lok Sabha Committee on Public Undertakings and our studies of the working of the construction agencies of some of the developed countries, a paper explaining the necessity, functions and the pattern of organisation of the proposed Central Ministry of Construction was prepared. Discussions on the subject have also been held in the Planning Commission. The Minister of Works, Housing & Urban Develop-

ment and the Secretary of the same Ministry have been apprised of the importance and the necessity of reorganising the existing Ministry of Works & Housing into the Central Ministry of Construction. The Bureau of Public Enterprises after studying the construction organisations of various Public Undertakings have also come to the conclusion that it would be in the overall interest of Public Undertakings to entrust their civil construction works to the Central Public Works Department for economic and speedy execution. Bhe Bureau *vide* their letter No. 156-Adv. (C)/Cir-30/68, dated 22nd January 1968, has recommended this procedure to the Central Administrative Ministries and has requested them to bring it to the notice of the Public Undertakings.

0.23. The Panel of Experts have highlighted the importance of full utilisation of results of research conducted in the National Laboratories. With a view to identifying specific areas of research in which work done in the Laboratories could be put to proper use, a meeting was arranged with the Directors of various Laboratories conducting research in Civil Engineering, the National Buildings Organisation and the Indian Standards Institution. It was agreed that the appropriate set-ups for greater dissemination of the results of research among practising technologists were the Indian Standards Institution, the National Buildings Organisation and the Indian Roads Congress and these organisations were requested to address themselves vigorously to this task. The Directors of Laboratories were also requested to bring to the notice of the Planning Commission specific cases in which implementation of new techniques was being hampered by administrative and other hurdles so that such problems could be resolved with the Heads of appropriate organisations.

0.24. It was anticipated that shortage of steel, cementing materials and timber would be felt in the Fourth Plan period if projects envisaged in the Plan were to be completed in time. In this context, it was decided to take suitable measures to achieve maximum economies in the use of all these three materials.

0.25. Studies of available literature on research conducted in the country and abroad indicated that savings of upto 30% in the weight of steel could be achieved by the adoption of high strength deformed bars for reinforcement purposes in lieu of smooth mild steel bars used at present. In February, 1967 a meeting was held in the Planning Commission with representatives of Ministry of Iron & Steel, Hindustan Steel Ltd., Structural Engineering Research Centre, I.S.I. and N.B.O. to chalk out programmes for production of high strength deformed bars in the country. In October 1967, the progress made in the field was reviewed. Production of cold twisted mild steel deformed bars has now been started in the country in the private sector. Feasibility studies are in hand for producing high strength deformed bars in the integrated steel plants in the public sector both by hot-rolling and by a cold-twisting. Use of deformed bars should, besides effecting a reduction in the quantity of reinforcement steel used, make for a reduction in construction cost. The publication "Savings in Structural Steel by Standardisation" brought out by the National Council of Applied Economic Research has highlighted the economy that could be achieved in the consumption of structural steel by adopting Indian Standard Sections. Although some Indian Standard Sections are being produced by steel mills, production of more sections especially the lighter series is necessary to derive maximum advantage of Standard Sections recommended by the Indian Standards Institutions. The Ministry of

Steel, Mines and Metals are pursuing the matter with the steel mills both in the public and private sectors. Production of a larger number of rationalised Indian Standard Structural Sections would yield appreciable savings in steel consumption by the construction industry.

0.26. To increase the availability of cementing materials for general construction purposes, various measures were considered in a meeting arranged in the Planning Commission in April 1967. Several important measures which, *inter alia*, included classification of Portland cement in two strength grades, have been forwarded to the Indian Standards Institution the Directorate General of Technical Development and the Cement Corporation of India and all others concerned. Implementation of these recommendations should result in economy in the use of Portland cement and in its more efficient utilisation.

0.27. Non-availability of good quality construction timber at reasonable prices is one of the difficulties faced by construction engineers all over the country. Particle Boarding which is manufactured out of waste wood is a good substitute for timber. Its adoption in lieu of timber in the construction industry is not, however, finding favour because of its higher cost compared to that of timber. Studies of the economics of production and marketing Particle Boards have revealed that the high selling price of Particle Boarding is to some extent due to high incidence of excise duty on raw materials and on the finished product. To consider measures to be adopted to encourage greater utilisation of Particle Boards, the matter was discussed in a meeting in the Planning Commission in June 1967. Representatives of the Ministries of Finance, Industry, and Agriculture (Department of Forests) and the Forest Research Institute and of the industry took part in the discussion. It was agreed that some modification of the tax structure in respect of this product was required with a view to reducing its selling price and overcoming the consumer resistance to its wider adoption in lieu of timber. Based on the recommendations of this group, the matter was taken up with the Ministry of Finance, who have since removed duty on finished particle boards. The question of making modifications in the rate of excise duty being levied on synthetic resins used in the manufacture of particle boards is under consideration.

0.28. Action by administrative ministries and other authorities on some of the recommendations embodied in this Report has been initiated. The issues on which action has been initiated though important do not cover the entire field. Some of the main issues have, however, yet to be tackled. If all the measures recommended are implemented significant economies in construction costs are bound to result therefrom.

0.29. **Acknowledgements.**—I would like to express my gratitude to all the members of the Panel who represent the top talent in the science, practice and business of construction in the country, for the keen interest they have taken in assisting us in bringing out this Report.

MAJOR GENERAL HARKIRAT SINGH

*Adviser (Construction)*

*Planning Commission*

NEW DELHI.

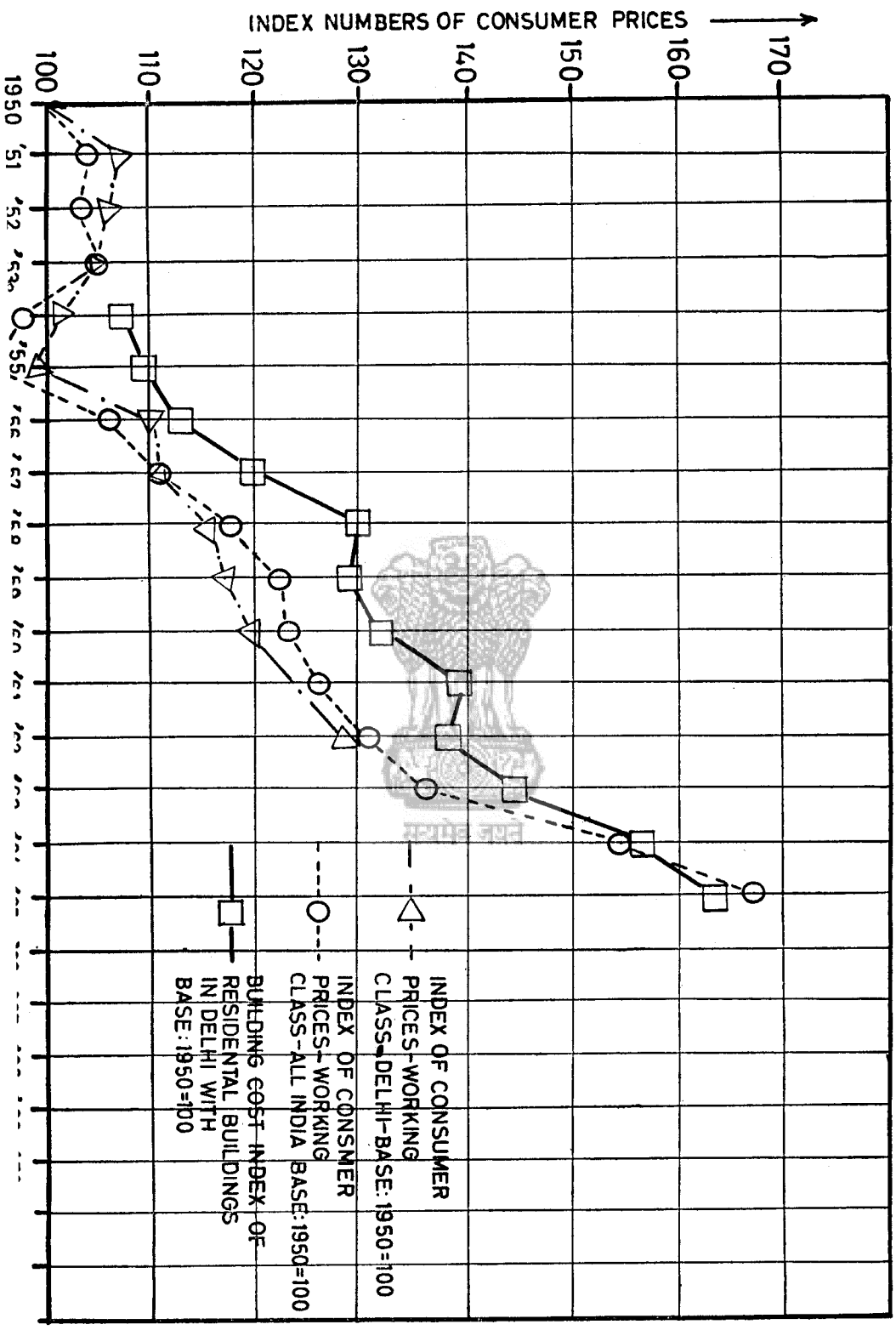
## CHAPTER I

### INTRODUCTION

1.1 Construction, both public and private, accounts for about 50% of the total outlay in any Plan. The quantum of construction has been gradually increasing over the years in consonance with the increasing outlays in each successive Plan. Along with the increase in volume of construction, costs have been steadily rising. An indication of this can be had from the chart at Fig. 1 which shows the trend of the building cost index for Delhi as compared to the cost of living index. Although the increase in cost of construction could be partly attributed to rise in wages, increase in cost of construction materials and rise in transportation costs, etc., nevertheless it is possible to achieve economy consistent with speed and efficiency and all efforts must be made in that direction. The solution to reducing construction costs in the face of a rising trend in the cost of living and a higher degree of sophistication demanded of the products of construction consequent to higher standards of living, lies in utilizing advances in technology and in adopting modern management techniques.

1.2 In recent years specific aspects of the process of planning and construction in the public sector have been examined by specially appointed committees. The committees have made important recommendations for changes within the existing framework of organisations. Even if recommendations of these committees are fully implemented, there will still remain a serious lacuna in Government's control over construction works being carried out from public funds, and its influence on the construction industry which stands at the centre of economic growth. *Ad hoc* efforts to solve particular facets are not likely to wholly solve the problem of reducing construction costs; the problem will have to be tackled in many directions. The process which every project has to undergo before work begins has to be speeded up to achieve targets of planned development according to schedule. Deliberate efforts will have to be made to develop and modernise the Construction Industry & the Construction Materials Industries rather than leave these to grow in an unplanned manner to meet the greatly increased demand.

1.3 The Construction Industry meets the requirements of Government organisations and the private sector involving a wide variety of clients. At present there is no single Government organisation which is in a position to influence its performance substantially and to assist and promote it or to be able to speak with unquestioned authority on its behalf and on the wide range of problems which concern the industry as a whole or to encourage the development of modern techniques and materials with confidence and to ensure proper utilisation of available resources. The scale on which modernisation is required is large and the problems involved are complex. The use of technical manpower, the communication of technical information, the collection and utilisation of statistics, the intensification of research and its application, the application of results of technological development which has been taking place rapidly in recent years, are all dealt with piece-meal because so many 'authorities' consider



themselves entitled to deal with these matters. The Construction Industry has to be organised so that it develops properly and utilises all aids and services which engineering management has at its disposal.

1.4 Some of the factors which contribute towards achieving economy in construction have been briefly touched upon in the ensuing paragraphs. Subsequent Chapters deal with these and other factors in detail under the following main headings :

- (a) Preplanning
- (b) Design and other Technological Factors
- (c) Construction Materials
- (d) Business of Constructing
- (e) Administrative and Organisational Factors
- (f) Motivation, Training and Publicity.

1.5 The greatest scope for economy in construction is at the preplanning stage. Every project should be planned as completely as possible before its execution is begun so that essential requirements are not over-looked and physical targets are achieved phase by phase. Preparation of designs in detail well before embarking on construction is vital in order to ensure orderly construction and speedy completion. For this purpose setting up of strong and well equipped design offices with accent on specialisation, at the Centre and in the States, where these do not exist at present, is essential. As Government and semi-Government organisations may not be able to cope fully with the volume of work expected during the Fourth Plan, it is necessary that consultancy practices are built up in the country, more especially for works of a special nature. The existing building codes and bye-laws are outdated and need to be modified.

1.6 Although in a large country like ours standards and specifications adopted for construction are bound to vary from region to region, there should still be some broad guidelines so that there are no wide disparities in standards of accommodation and in facilities provided in similar projects financed from public funds. It is not the intention to curb the initiative and imagination of engineers and architects directly responsible for carrying out works but to ensure a reasonable degree of uniformity in performance standards and in cost benefit ratios. Only an organisation having an overall view of construction activities of the country can lay down broad policies which will help eliminate waste and make for efficient utilisation of scarce resources both material & financial.

1.7 Introduction of such mechanisation in construction processes as is necessary to achieve quality, speed and economy is very desirable. In the case of road work, however, use of mechanical equipment is becoming increasingly important and almost inescapable.

Construction equipment consists broadly of two types *via*, mobile plant and stationary plant. To achieve sufficiency in their production and to reduce idle time which may be due to exclusive ownership, poor maintenance, or restrictions on release of foreign exchange for spares, standardisation, according of high priority to indigenous production, and setting up of

equipment pools on commercial lines and on a zonal basis, each zone being equipped with its own operational staff, repair facilities and modern methods of maintenance, are essential.

1.8 Quality control is necessary in construction projects of any magnitude and to be effective, it must be systematic and continuous. Quality mindedness should be inculcated in staff connected with every project. Field laboratories should be set up at all major construction sites. A large organisation should have central laboratory which should be assisted by field laboratories. Internal departmental check should be made systematic and responsible. Technical examination by an external agency cut across the functions of the responsible engineer and undermines the authority of the responsible head of a department, and needs to be done away with.

1.9 Materials constitute about two-thirds of the cost of any construction work. Serious shortages are likely to be faced in the Fourth Plan period in respect of construction materials unless appropriate steps are taken to overcome these shortages. For this purpose a Building Materials Assessment & Development Cell should be set up in every State and the National Buildings Organisation should act as a coordinating agency and lay down methodology for the purpose.

1.10 All construction irrespective of its nature is the result of efforts of technologists on the one hand and contractors and building materials industries on the other. These parties have to work as a team in joint effort. Most of Government contracts ignore this aspect and, therefore, throw a disproportionate share of the burden of unforeseen expenditure and risks on contractors. To obtain greater competition and to draw-in more qualified technical persons towards the construction industry, it is necessary that short-term and long-term measures are adopted to afford financial assistance to it as, at present, finance is obtained by the industry mostly from private parties at exorbitant rates of interest. If an independent Finance Corporation is set up for the purpose, it would constitute a suitable long term measure. Contract forms in use at present need to be revised so that these embody conditions which are equitable to both parties. There is also a requirement to prepare an All India Standard Schedule of Rates priced on a zonal basis as analyses of construction costs and their comparison are dependent mainly on a schedule of rates and there is a large number of these at present which give varying descriptions for similar items of work and varying methods of measurement resulting in confusion in the mind of contractors working for different departments.

1.11 Considerable rationalisation of accounting procedures for public works is essential so that interference and delays are eliminated by modifying out dated rules and procedures. Budget procedures need to be modified so that funds are assured during construction to conform to pre-planned phases of completion.

1.12 Motivation and incentives should be provided to get the best out of technical personnel engaged on construction projects. As these are largely concerned with psychological and human factors, such factors have to be taken into account. Incentives present an appropriate device through which motivation may be provided but these cannot by themselves meet present-day challenges where many complex human problem are involved. The present system of recruitment of technologists for construction of projects, on an

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*ad hoc* basis, is detrimental to works as apart from creating discontentment amongst staff, it leads to dissipation of expertise built-up during the course of construction. Terms and conditions of service of technologists working in public works departments and public sector undertakings need to be reviewed; pay and status of engineers and architects in Class I service should not be lower than the pay and status of officers belonging to any other All India Service for equivalent length of service. Formation of an Indian Service of Engineers, which has been agreed to be set up, should be expedited. Suitable awards should be introduced. Extreme degree of vigilance which has been exercised in recent years by various agencies is useful to some extent but it results in loss of initiative even at senior levels. Review of these measures is, therefore, considered essential.

1.13 Engineers and Architects in Government employment should be encouraged to attend refresher courses, advance courses, specialised courses, etc. to enable them to keep abreast of rapidly developing technology in the field of construction. Training facilities for construction tradesmen should be expanded. A system of certification of skilled tradesmen should be introduced. The category of master craftsmen should be built up.

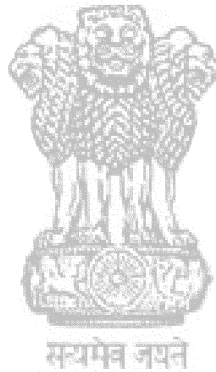
1.14 It is necessary to bring to the attention of technologists important technical information and data having a bearing on construction economy, of which a large volume is already available in the country as a result of past researches and construction experience. The N.B.O., I.S.I., C.W.&P.C, Indian Roads Congress and other similar organisations should extend their facilities to serve as clearing houses for technical information in their respective fields. Large engineering projects should publish detailed reports on all matters connected with achievement of efficiency and economy obtained during construction operations. An independent journal on 'Engineering Construction Economy' should be started.

1.15 The National Buildings Organisation is performing certain functions at present. It needs to be expanded and made autonomous so that it may perform the existing functions more effectively and, in addition, attend to the various tasks involved in assisting Buildings Materials Development & Assessment Cells in States, set up Development Groups for repetitive types of works, prepare an All India Standard Schedule of Rates priced on a zonal or other suitable basis, and disseminate technical information to a greater extent.

1.16 In order to achieve economy, efficiency and speed in construction works financed out of public funds, it is essential that the present system of public works administration be modified. The present system provides for unnecessary checks and restraints which lead to lack of faith and confidence and to a marked tendency to avoid taking decisions resulting in avoidable delays. It does not permit of bold actions and trials of new ideas and scientific advances. Planning and research involve expenditure which may not always produce direct results and these facts have to be recognised and accepted. It should be borne in mind that minor amendments to this or that regulation or recommendations of a general nature about design, specifications or contracts will not make the difference in efficiency which is now absolutely essential. Our approach has to be more dynamic and rules and regulations have to be framed with a view to speeding up the process of arriving at decisions. Adequate authority should

be given to heads of construction departments to discharge their responsibility and the present system of secretarial control should be abolished so that both responsibility and authority may vest in the Head of the technical department and his senior technical colleagues.

1.17 Implementation of the various measures outlined above will be greatly facilitated if a central organisation is charged with the responsibility of promoting the Construction Industry generally and of carrying out all construction financed out of public funds with the exception of construction relating to Defence, Railways and Irrigation & Power as these latter organisations are already suitably equipped for the purpose. The existing Ministry of Works, Housing & Supply could be appropriately reorganised and expanded to devote itself to these tasks.



## CHAPTER II

### PREPLANNING

2.1 After independence, due to the urgency for overall economic and social development and the necessity to make a quick start to fill the gaps in the country's immediate needs, a large number of Engineering and Industrial projects were started sometimes without adequate study of the requisite data. In several cases this has led to delayed execution of the construction phases avoidable extra-expenditure and consequent criticism. The main cause for such delays was that conditions contingent to the fulfilment of a project were at variance with the assumptions on the basis of which the project was prepared resulting in avoidable alterations in the schemes at late stages.

2.2. Every project should be examined and planned as completely as possible before its execution is begun to ensure that the user is not only provided with what is essential but completed phases of the project are made over to him in logical sequence. Such preplanning enables construction agency to organise the work efficiently and reduces to a minimum alterations in plans and details, caused by indecision and lack of information.

2.3 Before any scheme is taken in hand, it is necessary to visualise all factors which affect construction, operation and end-use of the scheme. It is only with detailed preplanning that construction could proceed without unpleasant surprises; and correct assessment of costs, benefits and time schedules made. Necessity for or otherwise of a project is largely governed by its need and end-use in the background of the national economy and its planned development. But the economic feasibility of a project largely influences this decision. Cost of construction accounts for a major share of the capital investment in any project, whether it is in the industrial, irrigation, power or transport sector. Any savings in construction costs would correspondingly reduce the strain on resources, will reduce overhead charges and thus will favourably influence the cost-benefit ratio. On the other hand any rise in the cost of construction will end up in disproportionate capital expenditure and upset the original cost benefit calculations and the economic viability of the project. The importance of studying the details of the construction aspect of a project is obvious. It is, therefore, necessary to associate the agency for construction of the project from the earliest possible stage in the process of project formulation so that this agency may do the necessary preplanning and advise the sponsoring authority suitably.

2.4 Sponsoring authorities when proposing a project should list details of main requirements and components indicating scope of the project. They should also indicate the extent of the burden which the proposed scheme will throw on other administrative units in the region. Such an action at the preplanning stage will not only be of assistance in expediting work but will also result in coordination between different administrative units in their construction activities. For instance, road and rail communications are necessary for development of a port or installation of a steel plant and in fact for establishment of any industrial complex. These modes of communication have to be examined from considerations of economical

transport of materials to and from the complex and the part these will play in the development of the region and opening up of the country. A project of this nature may, for purposes of administration, fall in the jurisdiction of one Ministry but its repercussions will be felt in other Ministries also and so the latter need to be appraised of the project potential and requirements at an early stage. Subsequently, possibilities of establishing new centres of trade and other aspects may have to be examined by other administrative units.

2.5. It is at the pre-planning stage that greatest economies in construction of projects can be achieved. Decision taken at this stage will have a major influence on the overall costs of projects. Subsequent factors such as choice of design, materials, techniques of construction etc. will have only a relatively small effect in reducing the cost of construction. Although the importance of pre-planning is well-known, it is this phase which generally gets neglected in the eagerness to make a quick physical commencement of projects.

2.6. **Surveys and Data Collection.**—After having established the need and end-use of a project the location of the project is the next step. Before a decision could be arrived at it is necessary to study a number of alternative locations. Although availability of raw materials, infra-structure and markets for end-products are important considerations due weightage should be given to the relative costs of construction of the project at different alternative locations. For this purpose, it is necessary to go through the process of collection, investigation and assessment of data so that detailed studies on relative costs can be made. Time taken in making this study should be considered well spent.

2.7. For large projects it will be necessary to carry out field investigations and collection of proper field data, viz. hydrological, geological, meteorological, climatological, etc. Soil and sub-strata surveys are to be conducted at possible sites for the project. Simultaneously, laboratory and field tests are to be undertaken with special emphasis on foundation studies. Correct appreciation of field data has a great bearing on the choice of the type of construction and specifications to be adopted as these ultimately influence costs.

2.8. In the case of large hydraulic structures, bridges, port and harbour constructions, model studies have to be conducted to decide upon the choice of site and type of construction. Before any project is envisaged, it is important to ensure that it does not result in any ill effects on existing assets. This aspect is particularly important in hydraulic structures. It is essential that new projects when completed do not create fresh problems like flooding, erosion, silting, etc. in other places. At the preplanning stage, Model Studies should be conducted to anticipate such difficulties and to adopt suitable measures in advance or to change location to another more suitable site.

2.9. Materials Survey forms another important aspect of preplanning. The availability of cheap local construction materials e.g. stone, sand, bricks, timber, etc. is to be studied. Wherever traditional building materials are in short supply, the possibility of utilising substitute materials is to be examined.

Relative costs of the materials obtained from different sources will have to be worked out and decisions taken with regard to their utilisation from economic and technical aspects.

2.10. For any large scale construction activity it is essential to ensure adequate supply of water and power for constructional purposes. Detailed investigations in this regard should be conducted at the preplanning stage. In certain cases from overall considerations of time schedule, it may be necessary to put up small separate schemes ahead of the main water supply or power schemes, to cater for constructional requirements. In others, it may be feasible to phase completion of main schemes in such a way that earlier phases could, when completed, meet constructional needs. It would also be necessary to make enquiries from local bodies and from other public utility undertakings in the area whether and to what extent they would be able to meet the demands of a project from their existing resources or from their projected schemes. All these factors have to be assessed to come to an economical solution. Provision of water and electricity by a central agency to different construction agencies engaged on a project as against each agency establishing its own sources will normally lower overall construction costs.

2.11. It has been observed that, in the ultimate analysis, transport charges account for a major portion of cost of any commodity. If we examine this problem it will be seen that in all activities, ranging from production of raw materials to final utilisation of a project, cost of transport is substantial. Conducting detailed and comprehensive studies into the transport problem of production units is, therefore, important. The analysis of the transport problem should also taken into account existing and projected facilities in the area and examine their utilisation to the full for the project before visualising any special arrangements. The problem should cover studies of all alternative modes of transport viz. road, rail and inland water transport. Availability of transport facilities and their development during period of construction and later for moving finished products to markets are to be studied in an integrated manner.

2.12. **Continuity in Data Collection and Pre-planning.**—In the past, sometimes data collection particularly in the case of industrial projects has been made on an *ad hoc* basis for specific projects. After the project has been finalised and executed this data is not readily available for use in other projects, as agencies for execution often varied. Many a time data collection has been hurried and hence could not be exhaustive. A large number of agencies have been collecting different types of data and these are not readily available at a central place. Data collection should be continuous and should be coordinated. Such data should be stored in a central place which should serve as a reference centre for future projects.

2.13. In irrigation and hydro-power projects, reliable and thorough information with regard to hydrology and floods has to be collected before any project is formulated. Gauging sites for measuring river discharge need to be established at several places. Some of the work in this respect is being carried out by States. Sometimes data collected by different States with regard to the same river do not agree and a correct assessment of the water resources becomes difficult. Collection and compilation of hydrological data should be a continuous process and should be done on an

All India basis and should not be terminated even when there is financial stringency. Development of water resources of the country should be envisaged on a river valley basis and not restricted to individual States. Formation of a Central Hydrological Survey Department for the purpose would, therefore, be necessary.

2.14. In some cases in the past preparation of feasibility reports for projects was started during a Plan period and in order not to lose time in commencing work or obtaining financial assistance from other countries preplanning studies did not receive the attention these deserved. Some of the sanctioned projects had to be abandoned or postponed in consequence while others had to be completely modified subsequently.

To avoid such situations from arising it is necessary to have continuity in data collection and pre-planning. Sufficient time should be allowed for planning effort between the project formulation stage and the beginning of construction work. The effect of this will be that investigations for many of the projects intended to be taken up during a particular Plan will need to be started during the earlier Plan period.

2.15. In order that data collection and investigations are carried out continuously there should be permanent staff with necessary equipment and transport facilities for this purpose. A new orientation in thinking in respect of staff requirements for planning is called for in all construction organisation/departments of the Centre and of the States. Permanent investigations and planning divisions will have to be set up in departments wherever they do not exist. Money spent on investigations and planning will pay large dividends in reducing cost of construction. Large projects should be planned from the outset by the best available talent and professional expertise so that subsequent screening and criticism may not necessitate wholesale changes in design and specification.

2.16. **Phasing and Programming.**—Construction of projects should be undertaken in phases so that benefits accrue from the earliest possible stage. Proper phasing is important for utilising trained manpower and equipment and for ensuring gradual development. Stage development of a generating station, for instance, makes gradual outlays possible. In addition it enables utilisation of initial generating capacity of the station for construction of subsequent phases. Trained manpower and equipment of the first phase can advantageously be utilised on subsequent phases. Correct phasing of projects is one of the many factors which affect cost and time schedule. It will not only cut costs and prevent unnecessary locking up of capital on items of work ahead of need but will enable increasing returns to be secured before the entire project is completed. Studies conducted by the Committee on Plan Projects have revealed that there is a wide gap between commitment of expenditure and raising of physical assets. For instance, building in residential colonies are often completed in advance of connected services with the result that these remain unoccupied for a long time resulting in loss of revenue. Proper programming and progressing of construction activities in phases have to be done in a scientific manner.

2.17. Modern methods of programming facilitate estimation of the optimum rate of input of various resources viz. financial, material, personnel, machines etc. Calculation of the optimum rate of financial input is an important factor and it is essential that this rate of input is ensured.

## CHAPTER III

### DESIGNS AND OTHER TECHNOLOGICAL FACTORS

3.1. One of the important stages for effecting economy in a project is the design stage as it is at this stage that all related factors are pieced together and balanced leading to evolution of a final blue-print. Expenditure could be considerably reduced by improving design components and altering features of a project as greater effort on designing is capable of resulting in considerable savings in the total cost of a project, the savings more than offsetting the increased expenditure on designing. During the last two decades considerable technological progress has been made in the field of construction engineering. If advantage is to be taken of results of research and growing experience in the country and abroad there should be willingness to adopt new designs, new materials and new techniques of construction.

3.2. Preparation of designs in detail well before embarking on construction is vital in order to ensure orderly construction, speedy completion and avoidance of subsequent errors. This will also result in economy as it will effectively reduce the "time cost" of a project in subsequent decision making. Although this aspect may appear to be obvious, it is necessary to mention it, as often it tends to be ignored in practice.

3.3. Modern civil engineering construction jobs are usually a combination of the systems of the "unique product production" and "mass production" techniques. Mass production jobs consist of repetitive items like buildings which lend themselves to standardisation and establishment of type designs. Unique product production jobs on the other hand comprise items like a dam, a power house, a turbine installation or a sky-scraper structure. Each one of these is of a specific type for which establishment of particular design criteria can be helpful. Such criteria should demarcate lowest and highest limits within which an individual design may be adjusted. This step should ensure against encroachment on safety of a structure while preventing its cost from going up.

3.4. **Design Criteria.**—In assessing the dead-load portion of total load coming on a structure, weight of the structure itself may account for as much as 75%. In designing, a clear functional assessment and evaluation should help to reduce the dead-load to a seasonable figure. For example, allocation of a separate space for storage in buildings instead of providing for storage over all floors and designing the sections supporting floors accordingly, should reduce sizes of these sections. Forces coming on a structure, which are in the nature of live-loads, and traditionally taken as maximum to provide an extra margin of safety. However, in taking combined effects probability should not be lost sight of. For instance in the design of hydro-electric structures wind and earthquake forces need not be considered to act simultaneously.

3.5. The Indian Standards Institution have standardised permissible safe design stresses for various building materials e.g. steel, concrete, timber,

etc. Codes of Practice for Structural Safety of Building Loading Standards, use of structural steel, cold formed light gauge steel structural members and steel tubes for general building construction, plain and reinforced concrete, timber, etc. have been published by the I.S.I. The use of relevant Codes of Practice for design of steel beams, plate girders, steel columns and struts has been explained in I.S.I. Handbooks No. 2 & 3. Various Indian Standards and Codes of Practice are being periodically reviewed by ISI with a view to bringing them in line with modern developments in the field of structural engineering. Designs illustrating standard procedures in the fields not already covered should also be brought out by ISI.

3.6. Designs based on the ultimate load theory should lead to more economical results. This, however, should be supported by due experimentation, testing and standardisation of materials after rigorous quality control.

3.7. Progressive design practices make use of latest advances in science and technology and these should be attempted wherever possible. Pre-fabricated construction components, prestressed concrete, shall and folded plate type construction, open web girders are some examples of developments in construction technology. Greater use of these developments and techniques will result in reducing construction costs. The use of welded structures as against the conventional riveted type of construction will result in savings in steel. For industrial buildings, workshops, etc. portal type construction may be adopted in preference to truss and cantilever-column construction. In structures where heavy loads such as those due to cranes are not encountered, tubular structures may be adopted, based on the Code of Practice for use of Steel Tubes in general building construction. Adoption of cold formed light gauge steel sections in purlins and structures not subjected to heavy concentrated loads may be considered as these result in reduction in weight of steel used. As cold formed light gauge sections are made from this steel strips, it is necessary to give these suitable anti-corrosion protection.

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3.8. Considerable advances have taken place in the science of structural analysis and amazingly fast calculating tools are available today. Use of Electronic Digital Computer and structural models as aids to design are two important examples. As these facilities are now available in places like the Structural Engineering Research Centre, Roorkee and some institutions imparting higher technical education, design engineers of Government departments and other organisations should make use of these to arrive at economical designs.

3.9. Where a large area is available for construction, structure tend to be dispersed. At certain stations, multi-storeyed construction could be adopted with advantage instead of having sprawling colonies of single and two storeyed residential flats. By dispersing buildings there is an increase in cost of services like roads, water-supply, electricity, plumbing and drains in addition to the cost of extra land and expenditure on day-to-day working and maintenance. Nature of foundations, climate, availability of skilled manpower, electricity for lighting, for lifts and for other purposes, etc. have, however, to be taken into consideration in deciding on the type of construction to be adopted.

3.10. Functional importance of structure should be adequately catered for with an eye on economy. For producing a pleasing structure elegance and economy should both be considered, weeding out non-essentials like curves, curved facings, and expensive stone settings. Aesthetics though desirable should come out of a pleasing combination of the essentials and not be working costly frills into a structure.

3.11. For any large construction project the importance of choosing the most economical solution out of all possible alternatives cannot be over-emphasised. This will depend on availability of necessary data from pre-investigations. Large dividends have been obtained in the past by adopting this course.

3.12. In the zeal to economise in cost of construction, durability of structures should not be lost sight of. Construction of initially cheap temporary buildings with inferior specifications is not the answer to real economy. Temporary buildings are uneconomical and wasteful in the long run and should be resorted to only when requirement is for a very limited period and is transient in nature. In addition to being uneconomical, temporary structures will cause indirect losses due to uncomfortable working conditions of users as a result of disturbances or stoppages of operations during frequent repairs and renewals.

3.13. The Fourth Plan envisages a large outlay in road development. Significant economies in road construction costs and maintenance expenditure can be achieved by adopting, wherever possible, cheaper scientifically based road construction techniques instead of conventional techniques. In accordance with the Government's 20 years Road Development Plan an estimated average thickness of 28 to 30 in. has been taken for all major roads. Out of the 30 in. crust the lowest 18 in. could be produced normally with locally available soil, compacted at controlled moisture content to a given minimum strength in replacement of the much more expensive hard aggregate now in use. Further saving could be effected if in the lower part of the remaining 12 in. top hard crust the specified stone or brick is replaced by local inferior aggregate, soil gravel mixture, soil-cement or soil stabilised with soft aggregates as the case may be. Wider application of modern design techniques in the practice of highway and air field engineering can achieve significant economies in construction costs, improved performance of pavements, expanded serviceability and reduced maintenance costs.

3.14. To derive full benefits from modern design/construction techniques, greater adoption of mechanised methods of road construction is necessary. This is essential to cope with modern vehicular loads and speeds. This will also enable speedy construction and stricter quality control resulting in overall economy.

3.15. **Standardisation and Modular Coordination.**—Standardisation is indispensable for increasing productivity in any industry. Some of the direct benefits from standardisation in the construction industry are given below :—

- (a) Organised production of construction materials ensuring consistency in quality and supply;
- (b) Reduction in variety, sizes and grades of building materials and components;

- (e) Development of construction practices by taking advantage of experience, technological advancement and availability of newly developed materials;
- (d) Reduction in cost and in waste at site;
- (e) Speedy construction;
- (f) Uniform measurement practices; and
- (g) Facility for training craftsmen, etc.

Though advantages of standardisation in the field of construction were appreciated many years ago, standardisation was confined to various construction agencies and departments which prepared specifications and schedules to suit their individual requirements and construction practices. In course of time, however, it was realised that apart from this departmental standardisation, standardisation at the national level was necessary. Accordingly under the auspices of the Indian Standards Institution, standards are being formulated covering, *inter alia*, specifications for building materials, building components and construction plant and equipment. Codes of Practice covering proper execution of work, measurement practices, sampling and testing procedures, etc. are also being evolved. Formulation of standards is, however, the first step towards achieving economy. Maximum contribution to productivity and overall economy from standards evolved at the national level will be possible only if Indian Standards and Codes of Practice are followed by different construction departments.

3.16. Repetitive items of construction in a work are such as could be standardised and/or mass produced. These items form about 20% to 30% of the capital invested in a project. Such items include whole units like buildings, residential as well as non-residential, workshops and stores structures, H.T. and L.T. transmission towers, etc. Standardisation could be adopted with advantage in respect of items like doors, windows, electrical fittings, ceiling tiles, roofing components, small bridge spans, scaffolding, etc. Considerable work on standardising steel sections has already been done by the Indian Standards Institution. Moreover the I.S.I. have constituted a number of sub-committees to deal with standardisation of various subjects relating to the field of multi-purpose river valley projects. Similar efforts should also be directed in other fields.

3.17. Further application of standardisation in building industry is modular coordination of dimensions. Modular coordination is achieved by establishing a common denominator or 'module' for laying down sizes of components. It gives a method by which dimensions of building components are determined in such a way that sizes of different components are related to each other and are chosen from a restricted and limited range of sizes, at the same time allowing freedom of design. In other words modular coordination is dimensional coordination between various building materials and components. This is not a new concept. In earlier days brick thickness of 3" played a significant role in the selection of dimensions for other related building components. With the introduction of new construction materials it became necessary to make an overall assessment of the problem with a view to laying down suitable module. Experience gathered by advanced countries was also taken into account. The basic module of 10 centimetres has now been accepted as the standard for purposes of modular coordination.

3.18. The principles of modular coordination are covered in IS 1233-1958 which deals not only with specified sizes of building materials but also with the planning of layout of buildings on the basis of modular grid. Dimensions of rooms and storey-heights should also be multiples of module. Modular coordination ensures quality, speed and economy by the method of mass production; it permits prefabrication and interchangeability of parts. It cuts down time consumed in preparing drawings, reduces construction time and provides a rational basis for standardisation of materials by manufacturers. The Indian Standards Institution should be entrusted with the task of preparing Indian Standards for commonly used construction components on the basis of modular coordination so that this system is adopted all over the country. It is considered that Government should make it obligatory for Government Departments and Public Sector Undertakings to adopt sizes and specifications stipulated in relevant Indian Standards as a matter of course. This will go a long way in inducing private builders to do likewise.

3.19. **Design Organisation in States, on Projects and at the Centre.**— With the accent on speed and economy at every stage of development, designs cannot be given a different treatment. Improvement in designs is a continuous process and can be best achieved through continued related research. Design and research are inseparable and sound and progressive designing should ensure that design trends are based on reliable research data. A competent design organisation in every field of construction activity should keep abreast of developments in science and practice of designing. It is, therefore, necessary that a suitable design organisation be set up in every State and for every large project. In addition there should be strong Central Design Organisations with accent on specialisation. Every design organisation should have an architectural wing which should be closely associated with projects from their initiation to completion of construction. Central Design Organisations are intended to act as consultants to whom references may be made by States & Projects Authorities for advice and guidance.

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3.20. A Design Organisation should have, *inter alia*, a Work Study Cell. Perspective Planning, Method Analysis, Works Improvement and Organisational Studies can all come under the purview of this cell. "Work Study Outfit" as a construction facility and as a management tool is not adequately appreciated by construction industry. It is in essence nothing more than a Planning and Research Unit not burdened with day-to-day design or construction responsibilities. Work Study Cell is intended to be continuously reviewing work areas and operations and to predict with accurate forecasts future trouble spots and their effect on time and cost of construction. Its participation should be more in the nature of assistance through 'consent' rather than as a hindrance through 'imposition'.

3.21. Design talent has to be recruited and trained. All is not well in this sphere in the Public Services of the country today. Individuals with very good academic record and with outstanding professional attainments are no doubt selected after careful scrutiny by agencies like the UPSC but they become frustrated within the first few years of service and there is a tendency among them to migrate from one job to another for personal betterment and possibly also for professional satisfaction. There are many factors which contribute to this state of affairs. In the limited sphere of

designs, however, the matter needs serious consideration. Frustration and demoralisation of design talent in Government Departments are rather conspicuous and this sets in a chain reaction which ultimately leads to increased cost of construction.

3.22. A closer look at this phenomena will reveal that most Government Departments in course of time become 'routine' offices lacking vigilance and dynamism. The existing outmoded service rules and working conditions are rarely changed with changing circumstances. The profession will stagnate without incentives for outstanding work and penalties for unsatisfactory performance. In these days of specialisation, continuity of personnel is essential for progressive designing. While this requirement is being met in part by some organisations in the country, interests of personnel engaged on design work are not always adequately safeguarded. Existing service conditions should be suitably modified so that professional talent is retained in the specialised fields in which it is engaged without the interests of individuals being jeopardised.

3.23. Design organisations should lay stress on specialisation and measures like incentives in the form of extra benefits should be taken to attract best brains to such organisations. For achieving efficiency and incorporating up-to-date techniques in designs, continuity of personnel in design organisations is essential. Design talent will stay on in the field of design only if effective steps are taken to ensure that individuals working continuously on design work do not lose their chances of promotion by staying in design offices. Design engineers should get promotion along with their colleagues in the executive field. Individuals should not be dislodged from appointments in design offices at the time of promotion because of absence of higher posts in such offices. If necessary, higher posts may be sanctioned for such offices to enable design engineers to continue therein.

3.24. Design engineers should, however, be given suitable opportunities to work in the field so that they acquire knowledge of practical difficulties which are encountered during construction. This will give them the required practical experience and enable them to foresee constructional difficulties so that suitable precautions against such difficulties could be taken at the design stage. Design engineers may either be attached to construction units for short periods or be placed in charge of construction for suitable periods. Thereafter they should be brought back to design jobs. Design engineers at all levels should be encouraged to visit construction sites where construction based on their designs is in progress so that they discuss constructional difficulties with field staff and review their own designs and detailing methods.

3.25. Government Departments and their related construction organisations normally produce designs in accordance with established practices. To make a break-through in developing new ideas, it is desirable to encourage competitive designing. In order to motivate the spirit of competition, incentives should be provided to structural and architectural talent in the country by arranging competitions particularly for designs for large structures, e.g. multi-storeyed buildings, bridges, etc. and for buildings of repetitive nature. Proposals incorporating alternatives for technological prizes and construction, use of a variety of new materials and technologies should be welcomed from the point of view of ultimate economy. Handsome prizes

3.27. With the experience available in the country, it should not be necessary to go in for foreign consultation in the field of construction. Foreign consultants are to be engaged only when the essential expertise and experience are not available in the country. They should be engaged only with the approval of highest technical authority in the field in which work is to be executed. If employment of foreign consultants becomes unavoidable, they should preferably be engaged through Indian consultants and be made responsible to them so that the requisite know-how in the particular field is built up in the country. The practice of entering into turn key arrangements with a foreign government or firm for design and construction of a project or a part thereof, some components of which could be designed and/or constructed with indigenous talent, should not be permitted as such practice inhibits the growth of Indian technology.

3.28. **National Building Code.**—Existing P.W.D. and municipal codes which lay down criteria for design of buildings and other particulars for incorporation therein are out-dated. In many cases provisions contained in these codes are wasteful as they do not cater for latest developments in the field of buildings design, construction techniques and materials. Moreover there is a lack of uniformity among various codes. With a large building activity on hand, an important step towards achieving economy in construction is the preparation of a National Building Code.

3.29. The main aim of the National Building Code is to promote uniformity of building regulations throughout India. It should form a complete document containing regulations which may be conveniently adopted or enacted for use by various departments, municipal administrations and public bodies. It should lay down a set of minimum provisions designed to protect the safety of the public with regard to structural sufficiency, fire hazards and health aspects of buildings. It should, *inter alia*, cover the following important aspects :—

- (a) Administrative regulations which pertain to the efficient and effective application of the Code, defining powers, duties and responsibilities of those concerned.
- (b) Definitions of terms and phrases used for the purpose of the Code to ensure understanding of the intended meaning.
- (c) Requirements to ensure safety from fire and health hazards related to the occupancy and use of buildings.

- (d) General design conditions and procedures and construction practices, structural loads, foundation design and construction design practices of reinforced and prestressed concrete, structural steel, timber, brick-work, masonry, etc., including permissible stresses.
- (e) Stipulations with regard to choice of type and grade of building materials for different locations and minimum standards acceptable from consideration of safety, durability and economy.
- (f) Regulations for air conditioning, heating, ventilating, elevator and other service equipment so that they function efficiently without creating a hazard.
- (g) Regulations for plumbing laying down size and quality of fixtures essential for sewerage, water supply and drainage.
- (h) Measures to ensure safety of workers and public during construction.
- (i) Housing code setting forth basic requirements for all types of residential construction.

3.30. The Code should incorporate latest developments in the field of building design, construction techniques and materials. It should give information with regard to field data as applicable to different regions of the country. It should serve as a medium to regulate building practices in India and to bring them in conformity with relevant standards, specifications and Codes of Practice issued by ISI. It should be so framed as to enable engineers and architects to adopt specifications and types of construction economically suited to different regions of the country.

3.31. The Code should be advisory. Its provisions should not be mandatory but should serve as a model for adoption by PWDs, local bodies and other construction agencies. Existing PWD and Municipal Codes could either be replaced by the National Building Code or suitably modified to cater for local requirements in accordance with the provisions of the Code.

3.32. The work of preparing a National Building Code has been entrusted to the Indian Standards Institution which has also been charged with the responsibility of reviewing the code periodically and keeping it up-to-date. That way the true national character of the Code will be maintained and strengthened and its development as a satisfactory set of desirable building regulations for use by Municipalities and other agencies steadily progress.

3.33. **Building Bye-laws.**—Private building construction in towns and cities constitutes a substantial portion of the building activity in the country. This construction is required to conform to local bye-laws which in most cases are out-dated and do not take into account latest advances in the field of building materials and design techniques resulting in uneconomical construction and waste of scarce national resources. To evolve a uniform pattern of building bye-laws, ISI have published IS 1256-1958 (under revision)—Code of Building Bye-laws—which corporations, municipalities, etc. should adopt with minor variations to suit local conditions. Instances are not lacking where in municipal building bye-laws walls constructed with

mud mortar and with cement mortar are specified to be of the same thickness. To remove such structural anomalies, it is necessary that the Standard evolved by ISI is adopted by all local authorities as the basis for revising their bye-laws. This will result in a considerable saving.

**3.34. Establishment of Development Groups.**—Public funds are at present being utilised on construction by Public Authorities, autonomous bodies, quasi-government undertakings and various organisations of Central Ministries and of States, besides the Central Public Works Department, the Military Engineer Services and the Railways which are the agencies which normally execute works for the Civil, Defence and Railway Departments respectively. Every agency carries out works to its own scales and specifications. To exercise uniformity in this respect with a view to effecting economy, it is necessary that certain basic standards of scales and specifications are laid down by a Central Organisation. These norms should be adhered to by construction agencies which utilised public funds unless variations are dictated by particular technical requirements.

**3.35.** For reducing building costs, covered space in buildings should be reduced, where possible, without affecting functional efficiency. This reduction cannot, however, be effected haphazardly. It requires scientific enquiry into requirements, careful consideration of activities which are to take place, the manner in which these activities are to be carried out and facilities and equipment provided for such activities. It is not the work of an engineer or an architect alone but is the combined function of a group representing all technological disciplines connected with a particular undertaking.

**3.36.** Based on the considerations mentioned in the previous paragraph, the Committee on Plan Projects have laid down norms and space standards for multi-storeyed office buildings, industrial estates, higher secondary schools, hospitals, hostels, etc. Similarly a Panel on Health Buildings constituted by the Ministry of Works and Housing has formulated reports on Primary Health Centres, Maternity and Child Welfare Sub-centres, Urban Health Centres and District T.B. Centres. Those reports should be made use of while planning for space.

**3.37.** Certain types of buildings are of a repetitive nature e.g. housing, schools, hospitals, offices. The National Buildings Organisation should establish a Development Group for each of these types which would keep user requirements, designs and specifications continually under review by experts in these fields. These Groups should evolve norms, space standards and layouts and help prepare economic designs for different regions of the country.

**3.38. Industrialisation and Mechanisation.**—In our country where unemployment and under-employment are serious problems, it has been the general belief that labour intensive methods rather than mechanised methods should yield cheaper products as cost of labour is low as compared to overhead costs of machines. The construction industry has been no exception to this belief. The time has, however, now come for re-assessing this opinion in the light of requirements of economy, speed and quality control so that physical targets of construction which may be envisaged in future Plans are achieved efficiently and in time.

3.39. In the country's efforts to improve the socio-economic conditions and the general living standards, speed is an important factor. Timely completion of buildings, factories, dams, power houses, etc. is a pre-requisite to starting subsequent economic and developmental activities as any delays in completion will result in delaying commencement of such activities. The pace of urbanisation consequent on the high rate of growth of urban population dictates speedy completion of a large volume of housing roads and other services. For the success of the various schemes for economic development and improvement of social services, the gap between commencement of investment and flow of benefits should be as small as possible. Speedy completion of construction phase will, therefore, contribute towards reducing 'time-cost' to some extent.

3.40. Judicious adoption of mechanisation in construction can also contribute towards economy. Even the cheapest labour can be expensive when employed in excessive quantities. It is conceded that it will be undesirable to substitute low-wage labour by costly machinery, specially if it requires foreign exchange; but it is equally unwise to employ a human chain to carry buckets of material for the construction of a roof when a simple rope hoist could do the same work at a fraction of the cost. "Cut and fit" methods increase construction time in projects. Delays entail higher interest cost on borrowed money.

3.41. Introduction of mechanised methods to ensure uniform quality in construction has become a necessity. In projects involving large quantities of earth-work, concrete work, steel work, etc. quality control cannot be exercised without adopting mechanised methods. In fact in certain fields mechanisation has become inevitable. For example, construction of roads and air-fields required to withstand modern loads and traffic is not feasible without use of mechanised equipment. With better quality control, structures can be designed with higher working stresses and lesser factors of safety leading to economy both in use of materials and in cost.

3.42. Although industrialised methods of building have come into vogue only during the past two decades, these are rapidly gaining popularity in developed countries. Adoption of such methods advantageously in a developing country like ours should be given serious consideration. The practice of designing each building for a specific purpose and constructing it by traditional methods involves delays. Requirements of users may have to be disciplined so that buildings conforming to prescribed modules may be accepted. Mass production of pre-fabricated building components such as beams, columns, wall panels, floor panels, etc. should be undertaken and these should be assembled at site. Installation of services in a building can be considerably simplified by making provision for these in wall and floor panels at the time of their manufacture.

3.43. Along with industrialised methods of building, mechanisation of handling of materials and components at site should also be gradually increased. The present methods of handling building materials by manual labour are often expensive. A judicious use of derricks, fork lifts, hoists, conveyors, etc. will increase speed of construction. Use of tower cranes and climbing cranes would bring in considerable savings in construction of tall buildings.

3.44. Apart from economy and speed, industrialised methods of building will ensure a higher degree of quality control than is possible in the case of *in situ* type of construction. Productivity of labour would be higher as building components are mostly manufactured under controlled factory conditions and not on open construction sites. Utilisation of equipment will be optimised due to regular production consequent on a steady demand for the same product.

**3.45. Indigenous Production of Construction Plant and Machinery :—** In the course of construction of various projects during the last 15 years there has been a gradual shift towards adoption of mechanised methods of construction. There has, therefore, been an evergrowing demand for different types of plant and machinery for the construction of roads, buildings, hydro-electric projects, factories, industrial plants, ports and harbours, etc. Equipment in demand consists broadly of two types viz., mobile plant and stationary plant. The most commonly used items are :

- (a) Earth moving machines namely crawler tractors with bull dozers attachments, motorised and drawn scrapers, dumpers, motor graders, front end loaders, excavators including different attachments, etc.
- (b) Concrete batching and mixing plant, aggregate and sand manufacturing plant, equipment for placing concrete, etc.
- (c) Air compressors, compressed air equipment for foundation excavation, quarrying, tunnelling, mining, etc.
- (d) Pumps, dewatering equipment and other related items.
- (e) Transportation and hauling equipment such as ropeways, etc.
- (f) Road making and allied machinery.
- (g) Dredging equipment.

3.46. In the past various users of construction equipment have been obtaining their requirements from abroad. Equipment has been imported mainly from USA, UK, West and East European countries, USSR and Japan. Due to difficulties in getting foreign exchange and with a view to achieving self-reliance in the manufacture of construction equipment in the country, efforts have already been made to start indigenous production of different items. Manufacture of excavators has already been undertaken both in the public and private sectors. Bharat Earthmovers Ltd. have started production of motorised scrapers, dumpers graders, etc in the public sector. Along with major items of equipment, indigenous manufacture of components and accessories has also been taken up. These include drawn scrapers, bull-dozer attachments, engines suitable for use in different machines, track parts and track components, etc. Thus definite steps have already been taken in the direction of indigenous manufacture. High priority should, however, be accorded to indigenous manufacture of the remaining types of equipment.

3.47. Indigenous production of construction equipment like pumps and dewatering equipment, air compressors and pneumatic equipment, concrete mixers, stone crushers, etc. may be regarded as adequate except for certain specialised items of high capacity.

3.48. With regard to specialised categories of road making machinery like rotavators, gritters, pressure distributors, cement and lime spreaders etc. the Working Group of the Planning Commission for Scientific Research has recommended that the Central Road Research Institute in conjunction with Central Mechanical Engineering Research Institute evolve suitable designs and produce proto-types for trials so that working drawings may be turned over to organised industries for the manufacture of these items. This is a step in the right direction and similar action may be taken for other items of construction equipment also. Facilities already available with organisations like Heavy Engineering Corporation, Ranchi, should be used for design and manufacture of heavy equipment. Long term planning of requirements of additional construction equipment and spare parts, for various items of work to be carried out, should be done taking into account quantities of work to be done, targets to be met, etc. and equipment available.

3.49. **Standardisation of Equipment.**—As pointed out earlier the various types of construction equipment available in the country at present have been imported mainly from U.S.A., UK, East and West European countries, USSR and Japan. Different construction agencies have procured equipment of different makes, models and sizes with the result that it is not possible at the moment to provide spare parts easily for all these machines. For indigenous production it is necessary to assess the various broad categories of equipment required for the construction industry and other industries like open cast mining, etc. where similar types of equipment are used so that a limited number of suitable makes and sizes of different machines may be standardised. A proper coordination in this regard is essential to avoid proliferation of makes and sizes. Standardisation will facilitate starting up of ancillary industries for manufacture of components, interchangeability of parts and speedier training of operators.

3.50. **Spare Parts and Policy regarding their Imports.**—For equipment manufactured indigenously, there have been difficulties in obtaining, even initially, required spare parts as these have not been covered by foreign exchange sanctioned under industrial licences issued to manufacturers of equipment. In the case of wholly imported equipment, initial requirements of spare parts should be permitted to be purchased with such equipment. Alternatively, authorised dealers should be permitted to import these parts against their own foreign exchange quota upto certain percentage of the value of each machine. This percentage may be suitable reduced after taking into account those items of spare parts which are manufactured indigenously.

3.51. It is understood that in the past users had difficulty in obtaining spare parts for imported earthmoving equipment. It is recommended that suitable procedures should be evolved so that better availability of spare parts and consequent better efficiency in the use of equipment may be achieved.

3.52. **Maintenance and Servicing.**—To obtain maximum efficiency from construction machinery, it is necessary to adopt modern methods of preventive maintenance, regular servicing at appropriate intervals and prompt repairs including provisioning of suitable spares to replace broken-down or defective parts. Systematic component exchange programme should also be introduced in all sectors to improve working of machines. Component exchange programme will be feasible only if types and sizes of different construction plant and machinery are standardised.

3.53. Data should be collected continuously on health and efficiency of earth-moving and construction equipment employed on various projects with a view to enforcing suitable performance standards. For example, in the Irrigation & Power sector, statements of health and efficiency of equipment are prepared based on equipment working two shifts and for 2,500 working hours of a machine in a year. This will improve standards of operation and ensure better availability of machines.

3.54. **Equipment Pools.**—In the public sector, at the time of commencement of projects new equipment is normally purchased and is often retained even after completion of construction. Instead of allowing common categories of equipment to be built up with individual users, it is desirable to pool such equipment on a zonal basis. The country should be divided into suitable zones and common categories of equipment required for different projects or organisations in a particular zone should become part of an Equipment Pool to be set up for that zone. The pool should be run on commercial lines and equipment issued to different works on a rental basis. On completion of its work on a project, the item of equipment should be returned to the Pool. This will prevent machines from lying idle in certain projects when there may be need for their use on other projects. Every Equipment Pool should be equipped with its own adequately trained operational staff and proper repair and maintenance facilities so that maintenance is fully taken care of. When special kinds of equipment are required for a particular project, such equipment may be directly procured and owned by that project organisation. Equipment Pools should be primarily intended to cater to the needs of construction works financed from public funds. There should, however, be no objection to equipment being hired to private agencies if it could be spared.

3.55. **Quality Control.**—Quality control is essential in construction projects of any magnitude. To be effective, quality control should be continuous for the duration of a project and should be organised in a systematic manner. Quality is a function of many characteristics and depends on materials, machines, methods and men. Quality control must, therefore, aim at controlling all these elements. Sustained effort is necessary at all stages to keep a careful watch on supply of materials, placing of materials, finishes etc. in fact over all operations at source of manufacture of materials and at site of work. Quality control is intended to prevent poor quality getting into the work rather than to correct poor quality after a construction or a part of it has been completed.

3.56. For organising quality control, quality mindedness has to be inculcated in staff connected with a project. Unless every member of an organisation takes pride in his work, it is not possible to achieve a standard which is really good.

3.57. All materials should be continually checked at source of supply and/or at site of work, as practicable. This is essential to ensure that materials of correct quality are permitted to be incorporated in work. Present methods of visual inspection and dimensional check are not adequate for acceptance and assessment of quality of materials and workmanship. Specialised laboratories will be necessary to carry out proper check and adequately trained staff will be required for the purpose.

3.58. In all major construction jobs, field laboratories should be set up to conduct systematic and continuous inspection and check of quality of materials and workmanship. These field laboratories should be staffed by right type of individuals. Sampling for testing purposes should be carefully done.

3.59. Construction Engineer should be assisted by normal supervisory staff and by field laboratory staff. Supervisory staff should be distinct and separated from laboratory staff. These two cells should be assigned distinct specified roles and their responsibilities should be laid down. Ultimately Construction Engineer must remain responsible for the job. Field laboratory staff should be under administrative control of Construction Engineer but technically independent of him and responsible only to a central authority (Project Head/Chief Engineer). This will ensure independence of action of laboratory staff and proper control as any tendency to execute bad work will be curbed by the existence of laboratory staff, corrective action being taken by Construction Engineer. There will be dereliction of duty on the part of Construction Engineer if he ignores data furnished by laboratory staff.

3.60. In a large organisation there should be a central laboratory which should be assisted by field laboratories and should exercise control over the latter.

3.61. Field laboratories and central laboratory should be provided with specialised equipment for sampling, inspection and testing of various construction materials and finished products. Adequately trained staff for handling this equipment and carrying out tests should be provided.

3.62. If a contractor is employed on a large work, he will have his own field laboratory. Departmental field laboratory and contractor's field laboratory should liaise with each other, Construction Engineer taking final decisions. Where responsibility for evolving a particular design rests with the contractor, he will naturally obtain approval of Construction Engineer to the design which he (contractor) proposes to adopt so that it is suitable and in accordance with contract requirements.

3.63. On a comparatively small work where a contractor has no field laboratory of his own, there should be no hesitation in associating the contractor with departmental field laboratory, administrative control of the laboratory being vested in Construction Engineer.

## CHAPTER IV

### CONSTRUCTION MATERIALS

4.1 In construction works materials generally constitute about two thirds of the total cost of construction. Along with the increasing outlays in successive Plans, the quantum of investment in construction has also been growing steadily. This has resulted in an increasing demand for construction materials produced by organised industries and for local materials. There has been a rapid increase in costs of materials during the last two decades and this has resulted in a marked rise in the building cost index. The rise in the cost of cement and in the cost of steel, from 1949 to 1968, is shown in the graphs at figures 2 and 3. Although there has been a slackening of economic tempo in the country during the past two years and demand for construction materials has decreased in consequence, their prices have not come down. With the launching of the Fourth Five Year Plan, it is expected that the tempo of construction in the country will pick up again resulting in an increase in demand for materials. If in the background of a sharp rising trend in prices, the demand for building materials also increases, prices may further rise disproportionately resulting in higher cost of construction. To prevent such a situation from arising and to stabilise prices, it is essential that adequate supply of building materials at reasonable rates is ensured at all main centres of construction activity. Unless prices of materials are kept under check, much headway in achieving economy in construction cost may not be made.

4.2. During the first two Plans the law of supply and demand and the intrinsic flexibility of building materials industries to adjust production to increasing demands had helped to tide over difficulties. During the Third Plan however, shortage of construction materials of required quality was one of the important causes of short-falls in targets. If another similar situation is to be avoided, serious attention has to be paid to carefully assessing the requirements of building materials and making detailed plans for their increased production and distribution. Deliberate efforts have to be made to establish new units to produce additional materials on more scientific and rational lines and also to develop alternative materials by utilising industrial and agricultural wastes wherever possible. Development of construction materials from waste products of industry and agriculture would in addition contribute towards development of the national economy.

4.3. **Building Materials Assessment and Development Cells.**—Before preparing any programme for production of building materials in various regions of the country, it is important to know before-hand the possible nature and extent of constructional activities that would arise location-wise. This may not be feasible unless a Physical Plan for national development is prepared concurrently with the formulation of Sectoral Plan. Only with the help of a Physical Plan, would it be possible to locate future centres of constructional activities and carry out assessment of requirements of materials vis-a-vis local resources. It is also important to work out economies of production of local materials with the help of field surveys. Although efforts have been made in the past to calculate overall demands of important construction materials like steel and cement, attention has seldom been paid to

# PRICE INDICES OF CEMENT

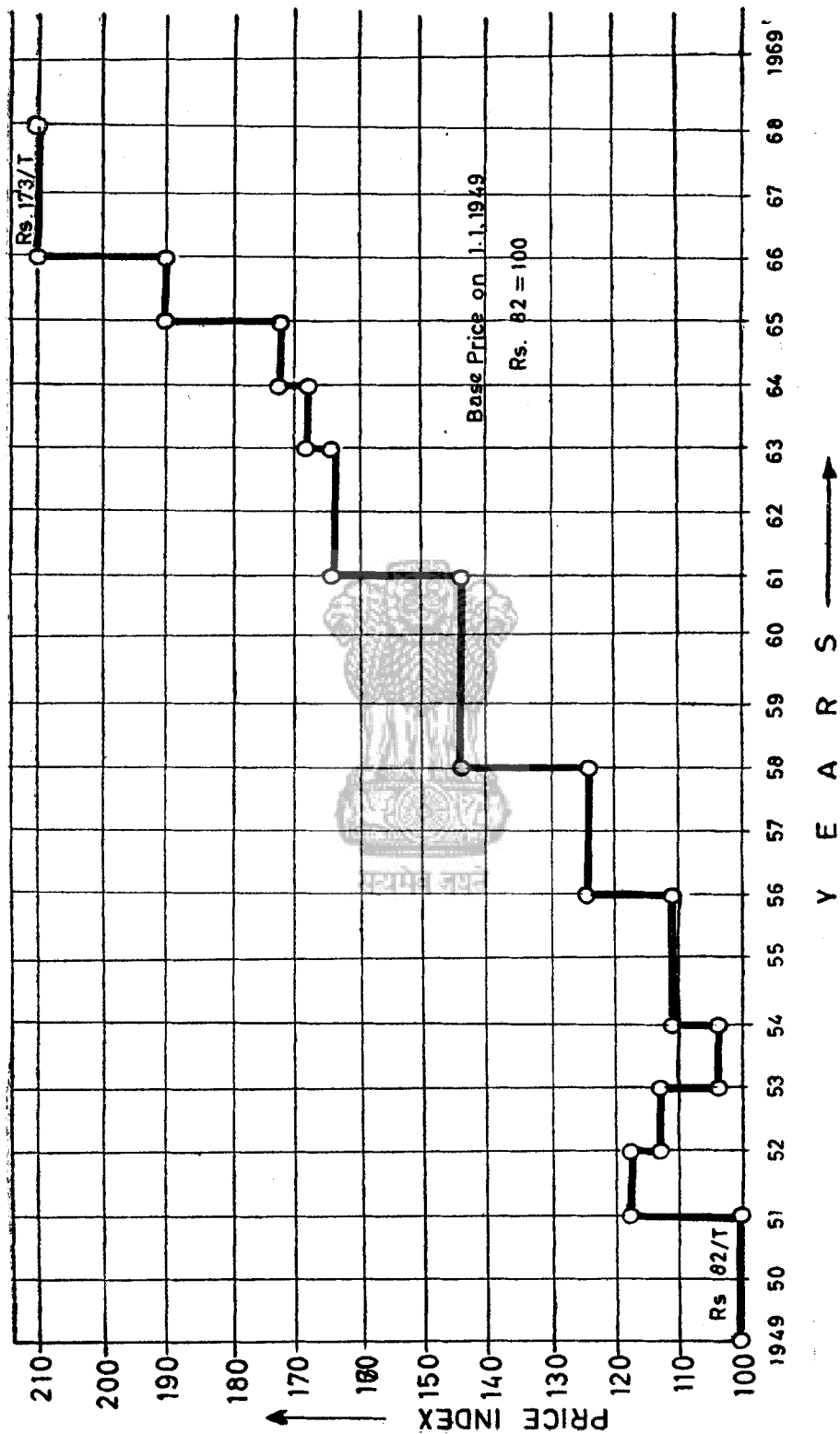


FIG - 2 (see para 4.1)

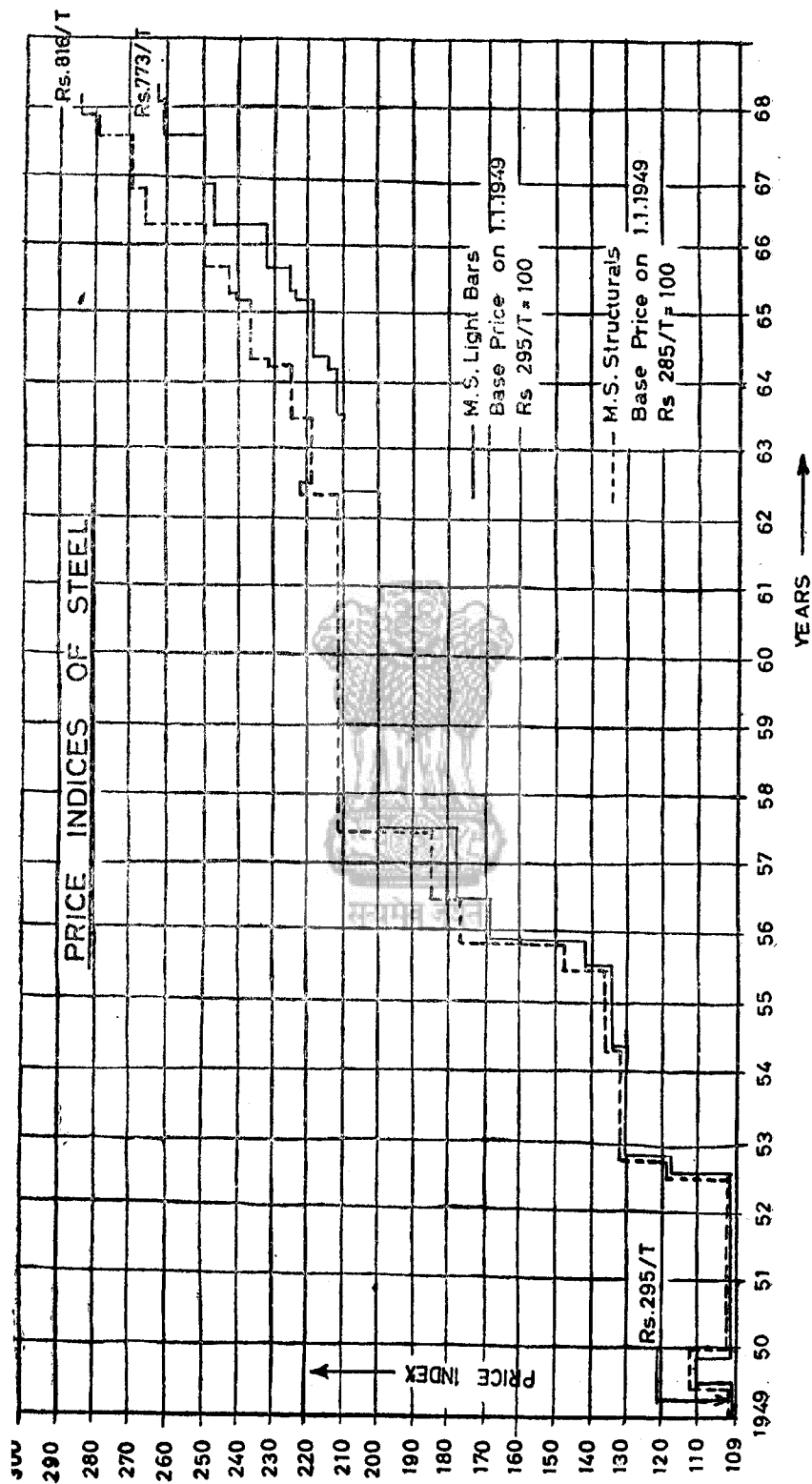


FIG - 3 (see para 4 1)

production of local building materials which account for a significant share of the total cost of any construction.

4.4. Work in connection with assessment and development of construction materials will necessarily have to be done at the State level as it involves a knowledge of detailed Physical Plans of development region-wise and conducting of field surveys to locate existing and potential sites for development of materials. A Building Materials Assessment and Development Cell should therefore be set up in every State to undertake this task. National Building Organisation should act as a coordinating agency. The Building Materials Assessments and Development Cell in every State should get in touch with various construction agencies such as CPWD, Railways M.E.S., State P.W.Ds and other local construction agencies, both in the Public Sector and in the Private Sector, for assessing requirements of building materials for the State as a whole location-wise and for development of sources of supply of materials for which demand is expected to be in excess of supply. The role of this cell should include development of both traditional and new materials which make for economy. Detailed methodology should be prepared by N.B.O. so that these cells in different States carry out the task on a uniform basis subject to minor local modifications.

4.5. Every State should be divided into important construction centres after taking into consideration volume of construction activity in different localities, which is dependent on the proposed Physical Plan of development and availability of building materials. Data in respect of supply position of materials should be collected by field surveys with the assistance of State Statistical Organisation. Gaps between supply and demand should then be worked out for different regions of the State.

4.6. In assessing requirements, two types of situations may arise, viz., establishment of centres of regular demand where demand is likely to increase with passage of time and areas of sporadic demand where demands may be created due to concentrated construction activity. In both cases, information with regard to future requirements should be made available to interested manufacturers well in advance.

4.7. The Assessment and Development Cell should have the necessary authority to effectively encourage development of building materials industries and to recommend setting up of new production units in public sector in case private sector is unable to meet demand. It should also have the authority to provide requisite facilities to entrepreneurs.

4.8. **Bricks.**—The clay brick is the most commonly used building material in most parts of the country. The small scale brick industry has the capacity and flexibility to adjust production to meet demand but when demand is large and sudden, prices go up and quality deteriorates considerably. Land prices around big cities are rising sharply and this is reflected in the unduly high prices of bricks. There is, therefore, an urgent need to acquire and earmark appropriate areas of land around such towns for brick making. States should conduct surveys to locate and determine suitable deposits of soils for brick making and earmark sites for this purpose in the Master Plans for urban localities.

4.9. The present methods of manufacture of bricks have a large scope for improvement in the practice of winning clay, moulding and firing. Intensification of research in these fields to evolve more efficient methods and an improved design of the Bull's-kiln should be taken up. Introduction of mechanised and semi-mechanised brick plants at this juncture is desirable to produce bricks of good quality at a reasonable price. Production of high quality bricks by such plants will result in overall economy as thickness of brick walls could be reduced to correspond to the strength of such bricks. Another advantage of mechanised plants is that a large variety of structural clay products can be produced by them e.g. perforated and hollow bricks, facing bricks, heavy duty bricks, sewer bricks, paving bricks, bricks for industrial floors and perforated tiles.

4.10. The present policy of issuing short term licences to brick manufacturers deter them from investing capital and adopting modern techniques. The licensing and pricing policy of Government should be worked out on a long term basis to permit continuity of manufacture.

4.11. It will be advantageous to have price control on bricks and to this end an equitable method of fixing fair prices of bricks linked to prices of coal, labour and land/land rents should be laid down. Credit facilities to brick and tile manufacturers on easy term will induce new entrepreneurs not only to enter the field and increase output but also to offer their products at competitive rates.

4.12. **Timber.**—Timber is one of the important construction materials used for a variety of purposes. During the second World War and the period which followed, there has been a rapid increase in the demand for construction timber with the result that forest resources of the country are gradually getting depleted. There is also considerable wastage of timber in the process of extraction, conversion and fabrication. If timber famine in the near future is to be avoided, it is essential that urgent steps are taken to achieve maximum efficiency in its utilisation.

4.13. Planning of a proper timber utilisation programme is not possible without adequate statistics of supply and demand. There is a lack of comprehensive and dependable statistics about the availability of construction timber of various categories *vis-a-vis* the present and future requirements of different wood using industries. Steps should be taken to collect regularly, accurate and detailed statistics of output of construction timber and trends of future production and demand. Forms in which Forest Departments record removals of wood from forests should be suitably modified to give sufficient details so that proportions of timber available for various uses may be ascertained.

4.14. Proper utilisation of available timber resources by efficient methods of extraction is the first step towards bridging the gap between supply and demand. Efficient and modern methods of felling, logging, storage, conversion and transport have to be given priority. For felling trees, cleaning boles and shapping them into logs, squares or sleepers, country axes, bill hooks, levers, wedges, etc. are used. These tools are not very efficient; their use entails much effort and also results in heavy wastage of timber. Modern methods of logging using improved basic logging tools and mechanised equipment for exploitation should be increasingly adopted by all Forest Departments.

4.15. Every Forest Department should have a qualified logging Officer to train forest personnel in charge of departmental operations and also contractors' men, in felling, fashioning and extraction of timber. These Logging Officers should give demonstrations and conduct time and cost studies to determine comparative efficiency of forest tools and equipment.

4.16. To make available improved basic logging tools and equipment at a reasonable cost and to save foreign exchange, Government should take up their manufacture in the country.

4.17. Methods of sale of timber trees to contractors by Forest Departments should be suitably modified to permit their sale in bigger lots and for longer periods so that operations may be mechanised. Such an arrangement will encourage contractors to invest in modern logging tools and transport equipment and induce them to construct paths and roads to facilitate transportation of timber by mechanical means.

4.18. The remote, so far unexploited or partially exploited, fir and spruce forests in the Himalayas, teak and sal forests in Dandakaranya and mixed forests in Western Ghats should be opened up to permit economic harvesting of available timber.

4.19. So far it has been the practice of various construction agencies in the country to specify use of traditional species of timber like teak, sal and deodar for construction purposes. As these species of timber are getting depleted, it is essential that the large quantity of secondary species of timber available in the country should be made use of. There are several species of secondary timbers which may be used for construction purposes after being given suitable seasoning and preservative treatment.

A list giving strength characteristics and other properties of common commercial timbers in India and recommendations for substitutes for teak and sal for building construction after giving them suitable seasoning and preservative treatment is given in Appendix-B.

4.20. If secondary species of timber are properly seasoned, given appropriate preservative treatment and marketed in standard sizes and quality with certified markings indicating species it will help to a large extent in increasing availability of construction timber. This will also relieve the pressure on the demand for traditional species which would contribute towards stabilising prices.

4.21. There is a need to educate consumers about classification and availability of secondary species of timber in various parts of the country. A thorough scrutiny of specifications adopted by various construction agencies is called for so that the situations in which secondary species of reasonable quality could be used are categorised. The present unnecessary rigid specifications regarding species and quality should, therefore, be revised. Although the Indian Standards Institution have already brought out IS 1331—1958 laying down standard cut sizes of timber, adoption of this standard by the timber industry has not made much progress. To avoid wastage during the process of conversion, users should be impressed upon to adopt these standard sizes to the greatest possible extent.

4.22. So far short length timbers have not been used on a large scale for structural purposes. Nail jointed timber trusses of different types and varying spans, laminated timber beams, portal frames, timber bridges and timber electric poles are examples of the use of short length timbers. Designs of various such structures utilising small dimensioned stock, secondary species and inexpensive joints have been evolved by the Forest Research Institute, Dehra Dun. These should be widely publicised and adopted wherever practicable.

4.23. The State Governments and Union Territories should encourage setting up of saw-mill-cum-wood workshops which should have all facilities for sawing wood into standard sizes, seasoning and preservation plants, and workshop facilities to produce standard pre-fabricated components like doors, windows, trusses, etc. Such integrated wood utilisation centres would pave the way to achieving economy in the utilisation of timber.

4.24. Another step towards efficient utilisation of timber is to convert waste timber into timber products like fibre boards and particle boards. Plants with an installed capacity to produce 45,000 tons of particle boards have already been set up in the country. Unfortunately these plants are working to a fraction of the installed capacity due to lack of demand for these boards. The reluctance on the part of construction departments and the construction industry to use particle boards is due to the fact that cost of these boards is higher in comparison with that of timber of equivalent size and quality. The main reason for the higher cost of particle boards is the incidence of excise duty on synthetic resins required in its manufacture. Modification of the tax structure in respect of these synthetic resins is necessary to bring down the selling price of particle boards. It is in the national interest to popularise use of particle boards in lieu of timber in order to preserve forest resources of the country.

4.25. Railways use a large quantity of timber in the form of wood sleepers and also in the construction of wagons. Although metallic sleepers are gradually replacing timber sleepers in many locations, the demand for timber sleepers is still very high. Timber sleepers should be substituted by prestressed concrete sleepers on a large scale except where timber sleepers are considered inescapable viz. track circuited sections, new embankments, etc. Substitutions of timber sleepers by prestressed concrete sleepers will release a large quantity of timber for construction purposes. Seasoned and treated secondary species of timber are already being adopted for wagon construction. In this type of construction increasing use should be made of substitute materials for timber.

4.26. **Quarried Materials.**—Quarried materials commonly used in Construction Industry are (a) Stone for masonry and road work, (b) Stone metal for road work, (c) Coarse stone aggregates for concrete work, and (d) Sand for concrete work and mortar required for masonry, brick work and for plastering. On the basis of very rough estimates, the annual requirement of stone aggregates for concrete work alone is of the order of 30 million cu.m. The annual requirements of coarse and fine sand are of the order of 20 and 30 million cu.m. respectively. There is a need to make a fair assessment of requirements of coarse and fine aggregates for every region in the country. The Building Materials Assessment & Development Cells mentioned in paragraph 4.3 should take up the task of estimating these requirements on a yearly basis.

4.27. Prices of stone aggregates have been going up. One of the important factors inhibiting increased production is the terms on which land is leased for quarrying purposes. Lease is at present granted for a period of about 5 years. This period is too small to warrant mechanisation of quarrying methods and construction of pucca roads to quarries to facilitate transport. The lease should be for a minimum period of, say, 10 years with possibilities of extension upto, say, 20 years. Royalty and tax structure of the industry also require study and rationalisation. These steps are necessary for continuity of production to be maintained. Ceiling prices should be fixed by local authorities to ensure economy and to prevent monopolies.

4.28. Stone aggregate for construction purposes is largely quarried by manual labour. This is a costly process and keeps output low. For increasing productivity in the field of quarried materials, modernisation and greater mechanisation have to be adopted at various stages of production. Efficient methods of mechanised drilling, blasting, handling, conveying to crusher, crushing, screening and transport to site have to be introduced. Provision of adequate spares and servicing facilities should also go side by side with mechanisation to prevent idle time due to break-down of machines.

4.29. As the stone aggregate industry is capital intensive, it needs the assistance of institutional finance.

4.30. Construction of pucca roads to major quarries should also be undertaken. This is essential to ensure supply of aggregates from quarries in all seasons of the year besides bringing down cost of materials due to freer movement. The use of tipper trucks for transport should be considered wherever feasible to reduce the cost of handling.

4.31. **Cementing Materials.**—Cementing materials form one of the basic items required in any construction activity. Among the various cementing materials ordinary Portland cement is the item which is most popular in the country. Towards the end of the Third Plan considerable shortage of ordinary Portland cement was felt but due to the subsequent increased capacity in the industry and the general slackness in the tempo of construction during the past two years, the situation has considerably eased. In the interest of economy in construction costs and with a view to making maximum use of available ordinary Portland cement and develop other types of low-cost cementing materials from industrial wastes. Production of blast furnace slag cement, Portland Pozzolana cement, lime of standard quality, lime reactive surkhi, are the possible alternatives to some uses of ordinary Portland cement.

4.32. Substitution of ordinary Portland cement by other cheaper materials for foundation concrete of low rise buildings, plastering, mortar for brick work and masonry, etc., would not only reduce consumption of cement but also lead to overall economy. Materials like lime and pozzolana mixed with cement yield desirable properties such as better workability, resistance to ingress of moisture, etc. Except in the case of large projects cement concrete is generally batched by volumetric methods. Increased adoption of weigh-batching and controlled concrete would yield economy in the use of cement and reduction in overall costs. Use of controlled concrete could be popularised by making available ready mixed concrete in areas of large construction activity and in metropolitan cities by installing ready mixed concrete plants in those places. In large cities, the present method of stacking

building materials on sides of roads, causes considerable inconvenience to public and interferes with traffic. Provision of ready mixed concrete will overcome this difficulty also. If ready mixed concrete plants are installed quality of concrete could be controlled and the use of cement restricted consistent with requirements.

4.33. Portland cement is manufactured in the country according to the relevant Indian Standard Specifications which stipulate the minimum strength requirements. Cements produced by different manufacturers yield strengths varying from the minimum stipulated in the Indian Standards to about double that strength. It is, therefore, obvious that cements having higher strengths are not being properly utilised except in large projects where production of controlled concrete is feasible. In order to achieve economy in the use of Portland cement, it is desirable to market it in accordance with its strength characteristics. It is for consideration whether ordinary Portland cement should not be marketed in more grades than on with a view to achieving more intensive utilisation. The matter has, however, been taken up with the Indian Standards Institutions and the Directorate General of Technical Development.

4.34. In many cases cement produced in factories has to be hauled over long distances before it arrives at construction site. Some waste and loss of cement, therefore, take place in transit. This is particularly significant when transshipment from broad-gauge to metre-gauge is involved. The present method of packing cement in jute bags, therefore, requires improvement if wastage in transit is to be avoided. Research and development work may be required to evolve improved methods of packing cement without increasing cost of packing. Transporting of cement in bulk should be adopted wherever it is feasible and economical.

4.35. In many locations of construction, cement can be substituted by pozzolana to a certain extent without sacrificing structural requirements. Use of cement pozzolana mixes instead of pure cement and of alternative building mortars such as lime pozzolana and lime reactive surkhi should be considered. Use of cement fly-ash mix for concrete will release cement for other constructional purposes.

4.36. Pulverised fly-ash is a fine residue that results from the combustion of ground or pulverised coal and is transported by flue gases of boilers. This is a waste material from thermal power stations. In concrete work pulverised fly-ash (P.F.A.) conforming to I.S. Specifications 3312—66 can be placed cement to the extent of 20 per cent of cement by weight without impairing the quality of concrete in any way.

4.37. Lime-pozzolana mixture which is essentially a mixture of building lime and pozzolana, such as burnt clay pozzolana, fly-ash, etc. could be used as an alternate cementing material to Portland cement for certain categories of work like masonry, mortar for plaster, concrete below floors and lime concrete foundations. If lime and pozzolana are procured by consumers separately and then batched and mixed by them, the required properties may not be achieved because of a number of factors which cannot be properly controlled. Production and marketing of properly mixed, ready to use and properly packaged dry mixtures of lime-pozzolana of specified strength would, therefore, go long way in making available a standardised product

that could be safely used in construction as substitute for Portland Cement in situations herein before mentioned.

4.38. It has been found that lime reactive surkhi mortars could take the place of cement mortars. Techniques have been developed recently in the CRRI New Delhi for the manufacture of lime reactive surkhi. A pilot plant has already gone into production. Capacity should be built up to manufacture 'factory produced' lime pozzolana mixes and the use of this material encouraged in substitution of cement wherever feasible.

4.39. The main difficulty in the wide-spread use of lime in the building industry is that it is not available in standard quality and slaking is not done scientifically. For house building purposes alone the requirement of lime during the Fourth Five Year Plan will be considerable. There is, therefore, a need to encourage the industry to improve design of kilns and to provide proper hydration facilities. Quality control should be introduced by providing testing laboratories at production centres.

4.40. To increase output of small producers, formation of cooperatives of small producers of lime should be encouraged. Government should make available to such cooperative societies appropriate quantities of lime stone of suitable quality. This may be done either through grant of minor leases or by ensuring regular supplies of good quality lime stone at reasonable prices from established lease holders. Such cooperatives should have ancillary testing facilities for controlling quality and a marketing organisation D.G.T.D. should include lime industry in the list of scheduled industries so that entrepreneurs may get requisite facilities.

4.41. **Steel.**—Due to rapid industrialisation and large scale developmental activities, there has been a heavy demand for steel for construction purposes. Production of steel has also been increasing under a planned programme. Annual production of finished steel has now reached the seven million tonne mark. During the Fourth Plan period, production of steel is likely to increase further. Due to the general recessionary trend in the economy of the country during the past two years, there has been a temporary slackness in the demand for steel. It is, however, expected that with increased tempo of construction activities which may follow the launching of the Fourth Plan; the demand for steel would also increase. In order to avoid any serious shortages in future, it is essential to harness all technological advances in the field of design and fabrication. A saving of one ton of steel is more important than production of an extra ton as saving does not require any extra investment or effort.

The National Council of Applied Economic Research in their publication "Savings in Structural steel through standardisation" have brought out that approximately 23% savings in structural steel could be effected by standardisation and rationalisation of steel sections, adoption of tubular construction and cold formed light gauge sections, and increased use of welding.

4.42. The Indian Standards Institution has already brought out Indian standards laying down dimensions and sizes of various types of structural steel sections in three categories, viz. Medium, light and junior series. The metric structural steel sections standardised by the I.S.I. are about 10%

lighter than the corresponding inch sections for equivalent load carrying capacity. The steel mills in the country have not yet started manufacturing sections of the light and junior series due to difficulties encountered in rolling such sections. To achieve full economy due to standardisation, measures should be taken to ensure production of lighter series of Indian Standard Steel Sections.

4.43. For light structures where concentrated heavy loads due to cranes, etc. are not encountered, use of cold-formed light gauge steel sections and tubular steel sections should be considered. Although tubular steel structures are being used of late, their use has been rather restricted due to high cost and limited supply potential. The high price of skelp required for manufacturing tubes is the major factor in the resultant high cost of tubular structures and this needs to be looked into. Cold-formed light gauge steel sections contribute towards a high percentage of saving in steel, but as these sections are produced from thin steel strips, it is important that suitable protective measures are adopted against corrosion. The high price of cold-formed light gauge sections come in the way of their being more widely adopted. The total quantity produced in the country is also limited. Incentives by way of reduction in excise duties may, therefore, be offered to lower the price and encourage their use on a wider scale.

4.44. Large savings in steel can be achieved through adoption of welded structures. To encourage use of such structures, existing facilities for training and testing of welders should be enlarged so that competent welders are available to the fabricating industry in sufficient number. Production of welding quality steel should be increased. Production of electrodes should also be increased to avert any shortage due to large scale use of welding methods. The fabrication industry in the country is largely oriented for production of rivetted structures. These fabrication shops require orientation towards welded type fabrication.

Capacity for fabrication of welded structures should be increased. Facilities for continuous welding of structural forms to give beams and channels special shapes with varying dimensions of webs and flanges should be made available by setting up suitable plants.

Use of high strength friction grip bolts in lieu of conventional bolts and rivets should be adopted where field connections cannot be avoided. Production of high strength friction grip bolts should be increased and their use by design organisations encouraged.

4.45 Modern design methods such as open web joist, rigid portal frames for factory and industrial buildings, space frames and plastic theory, should be increasingly adopted for steel structures, as such designs require lesser quantity of steel than conventional designs.

4.46. In developed countries high strength deformed bars have practically replaced mild steel plain bars for reinforcement of cement concrete. Besides many structural advantages, high strength deformed bars result in an economy of 30% over plain mild steel reinforcement bars. Production of high strength deformed bars by cold twisting has already been started in the country in a modest way in the private sector. Five re-rolling mills have entered into collaboration with M/s Tor Isteg Corporation for production of

"Tor Steel" type of high strength deformed bars. Efforts should also be made by the integrated steel plants in the country to manufacture high strength deformed bars. This should introduce competition and prevent any monopolistic tendencies. Development of suitable patterns for cold twisting is already in hand with the Structural Engineering Research Centre. Introduction of indigenous patterns will prevent payment of royalties. National laboratories should develop indigenous know-how for the production of hot-rolled medium tensile deformed bars also.

4.47. **New Materials.**—In view of the large demand likely to be created for traditional building materials in the Fourth Plan period, many such items will be in short supply. Efforts should, therefore, be made to use alternative materials in lieu of scarce traditional materials. Some of the alternative materials which could be substituted traditional materials are dealt with in the ensuing paragraphs.

4.48. There are many parts of the country where stone aggregate is not readily available and has to be transported over long distances for concreting purposes. In many advanced countries, clay, blast furnace slag and pulverised fuel are being converted into light weight aggregates and used to a great economic advantage in the construction of multi-storeyed buildings. The sub group on 'Building Materials and Man-power' of the Working Group on Housing & Urban and Rural Planning for the Fourth Five Year Plan instituted by the Ministry of Works & Housing, has suggested in their report the establishment of plant manufacturing 1,00,000 cu.m. expanded clay aggregates per year from Hooghly silt. Similarly there are possibilities of manufacturing foamed blast furnace aggregates from steel mills in the country.

4.49. Asbestos cement sheets and corrugated galvanised iron sheets are commonly used in sheeted type of roof construction. For the manufacture of asbestos cement sheets asbestos fibre has to be imported. Similarly zinc has to be imported for galvanising iron sheets. With the increase in building activities that may result with the launching of the Fourth Plan, the demand for A.C. Sheets and C.G.I. Sheets will also rise leading to larger imports of asbestos fibre and zinc. It is, therefore, necessary to develop alternative roofing materials utilising indigenous raw materials. Asphaltic corrugated sheets have been successfully used in many South American countries. Production of such sheets should be developed in the country and these should be widely used. To reduce the use of zinc, aluminised iron sheet should be developed and used in lieu of galvanised iron sheets.

4.50. Apart from increasing brick production through mechanised means and otherwise, use of alternative walling materials should be considered. One such material is cellular concrete which utilise fly-ash available as a waste product from thermal power stations. It has been decided to set up one plant at Madras for producing cellular concrete and it is proposed to instal another such plant at Bandel near Calcutta. Wherever price of burnt clay bricks normally exceeds Rs. 70 per thousand and fly-ash is available, feasibility of setting up cellular concrete plants should be examined.

4.51. At many places in the country where suitable clay to manufacture clay bricks is not available, sand lime bricks utilising sand and lime could be produced. One such plant has already been established in Travancore.

4.52. Our craftsmen in building trades are generally conversant with the use of traditional construction materials only. Along with the production of new construction materials, training of craftsmen in the use of such materials should also be taken up. This should enable them to overcome their reluctance to the use of new materials. This training could be imparted by Industrial Training Institutes, by manufacturers of new materials and by the N.B.O. Besides including use of new materials in the syllabi for regular trainees, I.T.I.'s could arrange short refresher courses and demonstrations for in service craftsmen. Manufacturers of some new materials *e.g.* alkathen pipes, polythene sheets, etc. had in the past arranged short courses and demonstrations for educating craftsmen in correctly fabricating and incorporating these materials/products in works. Such programmes could perhaps be sponsored and encouraged by the N.B.O. In addition, the N.B.O. could conduct short courses and demonstration in different parts of the country for the benefit of serving craftsmen.

4.53. Production of nearly all local construction materials is at present controlled by private parties. These industries are largely in the form of small scale units and lack organised development resulting in unplanned production and considerable variations in quality and output. This has often led to unjustifiably wide disparities in prices in different regions and even during different seasons in the same region although monopolistic tendencies and profiteering have to some extent been mitigated by controlling prices of some materials. Construction activities have in several cases been hampered due to irregular supply of local materials. Delays in completion of projects and increased costs have to some extent stemmed from the erratic nature of the supply of these materials.

4.54. It is in this field that the movement of cooperatives can give a fillip. Cooperative societies have certain distinct advantages over other agencies in tackling the problem. They develop the spirit of self-help, reduce profit factor and result in saving of expenditure. Costs of materials thus tend to come down.

4.55. The number of cooperatives producing construction materials at present is negligible. Their growth has been slow due to lack of encouragement. To overcome the present inertia in this direction and to develop the working of such cooperatives, special facilities may be extended by the Central and State Governments in the form of financial assistance, marketing facilities, laboratories for quality control, training of artisans, transport, etc.

4.56. **Materials Management.**—In large projects programming and materials management are essential for controlling construction costs. Detailed programmes for provisioning materials and for supplying them at appropriate time should be drawn up. Delay in supply of required materials at proper time leads to machinery and labour being rendered idle resulting in wasteful expenditure. On the other hand stocking of large quantities of materials much ahead of their use leads to unnecessary blocking up of capital besides involving possible deterioration in storage and in other overhead expenses such as watch & ward.

In large construction departments where sizeable quantities of stores are held in stock ABC analysis should be adopted as this analysis enables a selective control.

**4.57. Building Centres.**—There has been a rapid advance in the field of building technology during the last three decades. Socio-economic changes in the country have made a marked influence on the types of housing, services and facilities which are looked for by the common man. New design methods, new materials and new techniques of construction have been developed. Because of the rapid advancement, the average engineer or architect is not able to study, analyse and assess comparative merits and demerits of all new materials and methods. The average private house-builder may not even be aware of new developments.

With a view to disseminating knowledge of improvements in designs and techniques and to display new materials, Building Centres should be set up at prominent locations in large cities and important towns in the country. These Centres should give information with regard to sources of supply, availability, uses, costs, etc. of different materials and other relevant particulars. The primary object of a Building Centre shall be to provide a place where engineers, architects and all those, who are interested in construction, including members of the public, may see at one place a representative and upto-date collection of materials, techniques, etc., which are used for construction of buildings and structure in India. The Centre should also attend to enquiries and offer impartial technical as well as trade information.

**4.58. Objectives of the Centre** should be clearly understood by the construction industry. The Centre is not just a medium for advertising and for pushing up sales but is also intended to promote healthy competition with a view to improving quality of products manufactured in the country. It will provide relevant technical as well as trade information about products which would enable users to locate the right types of materials and to use them correctly. It will also provide an ideal opportunity to manufacturers of construction materials, components and equipment to display their products and to show their correct use in construction. Such information is essential for engineers, architects and builders. The Building Centre will also promote quality consciousness in the building industry. As a Government sponsored Centre, it must ensure that only quality products are displayed and consumers interests safeguarded. Though the Building Centre cannot be expected to guarantee quality of products and claims made by manufacturers, it can help weed out substandard products. The products displayed and information made available will be authentic, impartial and reliable.

**4.59.** The display of new products would also help the introduction of new materials wherever economical and practical. As the construction agency is generally averse to absorbing new materials, publicity given by Building Centres will help encourage users in the public and private sectors to adopt such materials.

## CHAPTER V

### BUSINESS OF CONSTRUCTING

5.1. Production of a building or a structure is the result of the efforts of engineers and architects on the one hand and of contractors & building materials industry on the other. These parties have to work as a team in a joint effort. Lack of appreciation of this fact has led to certain unsatisfactory features in contract conditions and in the working of contracts. Most Government contracts throw a disproportionate share of the burden of unforeseen expenditure and risks on contractors and, in consequence, tenders tend to be high.

5.2. The quantum of construction in the First and Second Five Year Plans was below the available capacity of construction industry and accordingly no action was felt necessary to take any active measures to expand or improve this industry. Therefore, it appears that in the Third Five Year Plan it was assumed that the construction industry would continue to expand automatically to cope with whatever load was thrown on it. In the middle of the Third Plan, however, the industry was severely strained to meet the increasing demand. This state will be aggravated when the economy starts expanding. It is, therefore, necessary to take measures to expand, improve and encourage this industry.

5.3. **Finance.**—Finance forms an important input for the development of any industry. At present builders obtain finance mostly from private parties at exorbitant rates of interest; *ad-hoc* payments from clients are extremely limited. As 'construction' is not treated as an 'industry' and contractors are looked upon as traders', borrowings from banks are also extremely limited and banks do not normally give loans or permit overdrafts against the security of contractor's fixed assets. They, however, agree to give cash credit against contractor's stores in hand with a 30% margin and work in progress, which is not yet billed for to clients, with a 40% margin. Contractors, therefore, constantly find shortage of liquid funds for taking on new contracts, for financing those in hand and for procuring new plant. In order to modernise the construction industry, to speed up construction, to draw-in more qualified technical personnel towards this industry and to lower construction costs by introducing keener competition, it is essential that short term and long-term measures are adopted to afford financial assistance to the construction industry.

5.4. Existing facilities available to the construction agencies for arranging required finance may be categorised under the following sub-heads :

**(a) Public, private Ltd./joint stock, construction companies**

These companies, which are about 30 in number, normally make arrangements for finance as under :

- (i) Borrowings from their bankers against moveable and immoveable assets. This facility is, however, available to a limited

extent only as fixed assets are generally comparatively far less than moveable assets.

(ii) As *ad-hoc* advance payments from clients against

(A) Machinery and plant brought to site. Such advance payments are available from a limited number of clients. Moreover these are available against bank guarantee only and are limited to a maximum of 5% to 10% of contract value.

(B) Non-perishable materials brought to site.

(iii) Their own working capital.

(iv) 'Private' deposits—These are available to a limited extent at a very high rate of interest and that too for short periods only.

**(b) Partnership and proprietary concerns**

In the case of partnership and proprietary concerns, finance is arranged by borrowing from (private) money lenders at exorbitant rates of interest and from their own limited resources. Generally banks do not finance such concerns.

From the information furnished above it will be evident that only a limited amount of finance is available from banks or from clients. It is also difficult to raise funds on reasonable terms from other sources. Therefore out of necessity, money has to be borrowed from private parties at high rates of interest. This contributes towards increasing cost of construction as contractors cater for such heavy payments towards interest, in their tender. In order to afford financial assistance to the Corporation industry in the interest of economy, short term and long term measures are considered essential. Some such measures are enumerated hereinafter and are recommended for adoption.

5.5. Short terms measures to cover advance payments to contractors working for Central Government departments, Public Sector Undertakings, autonomous bodies, etc. could consist of the following, payment being made out of normal budget allotment :

- (a) Against supply of acceptable non-perishable materials brought to site and not incorporated in work;
- (b) Against bank guarantee or fidelity bond of an insurance company, in case of contracts valued at over Rs. 20 lakhs;
- (c) Against machinery (tools and plants) brought to site, in case of contracts valued at over Rs. 20 lakhs;
- (d) On execution of essential preliminary items of work, such as huttings for labour, site offices, etc. and against guarantees, in case of contracts valued at over Rs. 10 lakhs.

5.6. To relieve contractors from blocking their working capital in the form of earnest money, security deposit/retention money, they should be allowed to deposit bank guarantees or fidelity bonds of insurance companies.

This will enable them to invest such amounts in work without recourse to borrowing corresponding sums from market at high rates of interest.

**5.7. Construction Finance Corporation.**—The existing financial institutions such as the Industrial Development Bank, Industrial Finance Corporation, Industrial Credit and Investment Corporation and National Institutes Development Corporation, do not cater to the needs of the construction industry as they do not treat 'construction' as an 'industry'. In view of this it is necessary to set up a financial institution to cater mainly to the needs of this industry. The proposed Corporation should advance funds on reasonable terms to—

- (a) contractors engaged on construction;
- (b) construction materials industries;
- (c) consulting engineer organisations.

**5.8. Establishment of a Construction Finance Corporation will result in substantial benefits as may be seen from the following :**

- (a) The present methods adopted by the construction industry are outdated, wasteful and slow. In spite of the necessity of providing employment to labour, mechanisation in certain fields is essential not only from the point of view of economy and quality control but also for improving speed of construction. The Construction Finance Corporation could provide funds for procurement of machinery. Where machinery has to be imported the Corporation could do so in collaboration with agencies like the I.D.A. by covering the foreign exchange component,
- (b) At present except for a few well established firms, most of them obtain finance either from financiers who join them as partners or from other sources and interest varying from 15% to 24% is paid. This is added to cost of construction which goes up correspondingly. The Construction Finance Corporation could step in and provide medium term and long term loans at reasonable rates of interest.
- (c) More entrepreneurs, especially qualified technical personnel, will enter the construction industry, taking advantage of institutional finance. Consequent keener competition in tenders is, therefore, likely to result in a downward trend in construction costs.

**5.9. Loan or financial assistance could be secured as under :**

**(a) Contractors**

- (i) by hypothecating or mortgaging plant to be purchased;
- (ii) against an acceptable bank or insurance company's guarantee;
- (iii) any other acceptable security.

The borrower shall also insure plant and machinery to the satisfaction of the Corporation. He shall in addition give personal guarantees of such

of the Directors of the company as the Corporation may decide; in case of partnership firms by all partners and in case of proprietary firms by proprietors.

**(b) Construction materials industries**

- (i) against an acceptable bank or insurance company's guarantee;
- (ii) against fixed assets and stocks of available raw-materials;
- (iii) by insuring materials to the satisfaction of the Corporation.

The borrower shall in addition give personal guarantees as in sub-para (a) above.

**(c) Consulting engineer organisations**

- (i) personal guarantees of partners;
- (ii) life insurance cover.

5.10. Although the Construction Finance Corporation would be autonomous character, steps will have to be taken to ensure that its working does not suffer on account of procedural formalities. For example, if applications for loans have to be placed before the Board of Directors in all cases, considerable delay may ensue in sanctioning them and in making payment. To overcome this drawback the Chairman of the Corporation could be empowered to deal with applications for loans upto a specified amount and to report to the Board at the next meeting the loans sanctioned by him together, with the terms on which these have been sanctioned.

5.11. The Head Office of the Corporation should be located in a region where there is considerable construction activity. The Corporation should be given powers to set up branches in other suitable localities as and when necessary. Verification of personal guarantees may present difficulties but if enquiries are made in proper quarters and Zonal or State Advisory Committees are set up for the purpose, as and when necessary, it may be possible to deal with applications for loans expeditiously and without much risk. Speed is of the essence in deciding, in consultation with the Corporation's solicitors, whether or not guarantees offered are adequate and also in executing loan agreements and, if delay occurs in making enquiries about applicant's antecedents, the advantages anticipated from the establishment of the Corporation would be minimised.

5.12. The rate of interest to be charged to beneficiaries of the Corporation could perhaps be fixed at, say, 1% higher than the rate at which the Reserve Bank advances money to other banks. This should also cover administrative expenses of the Corporation, which may be of the order of 1% of sums advanced.

5.13. The acceptable guarantees referred to in paragraph 5.9 above, which beneficiaries will be required to furnish, will cover payment of instalments and interest. The Corporation should, however, have the authority to grant an extension of time, where necessary, for return of the loan. Any disputes between the Corporation and its beneficiaries should be decided by the Chairman functioning as an arbitrator.

5.14. To start with the Corporation may have an equity capital of Rs. 100 million. The capital required by it may be arranged from the following sources :

- (a) Government contribution,
- (b) Contribution by banking institutions & L.I.C.

5.15. **National Register of Builders.**—If building and civil engineering works are to be executed soundly, economically and speedily, contracts must be placed with competent and responsible contractors. The prevailing belief that the best value for money is obtained by inviting tenders from all and sundry and concluding a contract with the lowest tenderer is not justified. On the contrary, low prices resulting from indiscriminate tendering lead to bad work and lower the standards of honesty and craftsmanship in the industry. Tenders should be issued to selected contractors & selection should be based on contractor's reputation for honesty, knowledge technical ability, employment of suitable and adequately qualified technical staff as and when necessary, adequate financial and organisational resources, etc. Work requiring a particular knowledge and skill should be entrusted only to those who have previous experience and knowledge in that field.

5.16. To facilitate modernisation of construction techniques and to increase productivity it is necessary that construction be treated as an industry. The construction industry should be encouraged to organise itself to adopt modern techniques, to employ properly qualified staff and to equip itself with modern construction equipment and machinery. For this purpose, building firms and contractors who are considered suitable for executing large works (each costing, say, Rs. 20 lakh and above) should be brought on a National Register after careful examination of their capabilities, qualifications and other relevant factors. This system of registration will encourage development of healthy codes of conduct, improvement of technical competency and betterment of general standards in the industry.

5.17. Although, generally, different construction agencies register contractors for work in their respective departments, registration of contractors who could be permitted to work in any part of the country in different specified fields and for different construction departments of the Centre, the States, Public Sector Undertakings, etc. is not done at present. Absence of this information results in delay in selection of suitable contractors for different types of works. It is, therefore, necessary to introduce a system of registration on an All India basis.

5.18. The task of preparing and maintaining an All India Register of Builders should be entrusted to a National Authority which should be set up under the proposed Ministry of Construction (see para 6.7). Till such time as the proposed Ministry of Construction is formed, the National Authority should function under the present Ministry of Works, Housing & Supply. Construction departments of Government and professional institutions should be represented on this National Authority. This Authority should lay down qualifications and criteria for enlisting builders in the National Register. It should also lay down a procedure for scrutiny of performance of builders in order that retention or otherwise of those borne on the Register is kept constantly under review.

5.19. An additional advantage of preparing a National Register of Builders is that it will eliminate personal preferences, prejudices of individual

officers in selecting suitable contractors for different construction works. Steps should, however, be taken to ensure that tenders for any work costing Rs. 20 lakhs or above are issued only to contractors whose names are borne on this Register.

**5.20. Labour Cooperatives.**—Labour cooperatives should be encouraged to undertake construction works. Although the cooperative movement in India has been in existence for some time, the system of labour cooperatives has not made much headway. This system besides increasing incentive of workers is likely to reduce costs of construction. The main reasons for the retarded development of labour cooperatives is lack of requisite facilities. Cooperative departments of States should encourage and organise labour cooperatives and explore possibilities of providing opportunities for such cooperatives to carry out construction for which these are suited. Construction departments should encourage cooperatives by offering concessions in the matter of earnest money and security deposit retention money. In the initial stages, labour intensive items of works, e.g. roads, embankments, irrigation canals, etc., should be given to such cooperatives. After these have gained experience, concrete work, masonry, brickwork, roofing, etc., may also be entrusted to them. As far as possible materials should be supplied by construction departments to keep working capital of cooperatives to a minimum.

**5.21. Contract Forms.**—Standard Contract Forms in use in Government Departments throw on contractors an undue share of risk of unforeseen conditions. Terms of payment and settlement of disputes are not equitable. Capital gets unduly locked up in the form of earnest money and security deposit/retention money. If prices to be quoted by tenderers are to be fair to both parties, conditions of contract must not be unreasonable or vague and open to argument. Financial arrangements should be equitable and payments prompt and powers of supervisory staff to suspend work, to order deviations and to reject work should be clearly defined. These reasonable and essential conditions cannot be said to prevail at present. As a large proportion of construction is done through the agency of contractors for achieving economy it is essential that all factors which contribute towards an avoidable increase in cost are eliminated.

**5.22.** Most of the recommendations made by the various high powered committees which have reported on the subject in recent years after making a thorough examination of the problems involved are not dissimilar from one another but are largely still mere recommendations. It was considered necessary to evolve Standard Contract Forms for Construction Works, in which general conditions were fair and equitable to both parties. A Committee was, therefore set up by the Planning Commission for the purpose and the preparation of a Standard Contract Form has since been completed and copies distributed. It is recommended that this form be adopted by all governmental construction agencies with such minor modifications as may be necessitated by local requirements.

**5.23. Lumpsum Contracts.**—Contracts should, as far as possible, be concluded on a lumpsum basis. This ensures acceptance of final cost. It also ensures that an experienced contractor will handle the work. Supply of all details of the work including working drawings, specifications, Bills of Quantities or Schedules of Works, etc. to tenderers, along with tenders becomes obligatory. Tenderers are given sufficient time to submit carefully worked out lumpsum quotations for the work. After conclusion of

the contract no measurements are involved except in case of deviations and if deviations are kept to unavoidable minimum, preparation of the final bill and its payment to the contractor becomes a comparatively simple affair. In such contracts running payments can be made to contractors either at agreed stages of execution of work or at agreed intervals without measuring the work every time an advance payment is made. Cost of the work is broken down into various stages and running payments made on the basis of this breakdown with reference to the stage at which construction has reached when a running payment is due to be made. This method of contracting, therefore, makes, for efficiency and economy.

5.24. As lump sum contracts based on Bills of Quantities require special training in the preparation of Bills of Quantities, specialised training in Quantity Surveying should be imparted to the persons concerned.

5.25. **Selective Tendering.**—It has already been brought out in para 5.15 why selective tendering is important. Selective tendering should not be resorted to in large jobs only. It is equally important in small jobs also as such jobs should not be regarded as being within the capability of every contractor. Work of any kind, however modest it may appear, can be mishandled and skill, competence and resources are of as much relative value in small jobs as in large ones. Normally reasons which are advanced for rejecting a tender after it has been received and examined apply for not selecting the particular contractor for issue of the tender to him. It seems futile to ask a tenderer to submit a tender and to put him to the expense labour involved in working it out when it is to be subsequently rejected on grounds which would have justified rejection of his request initially for issue of tender documents.

5.26. Competitive tendering is the normal and the most satisfactory way of determining prices for buildings and civil engineering works. Negotiated contracts should be an exception. If a representative range of contractors with adequate technical experience and financial and other essential resources at their disposal are invited to tender, prices should be adequately competitive. Engineering authorities should be empowered, where necessary, to accept tenders which are not the lowest.

5.27. Where suitable and better class of contractors are not attracted to any particular department/undertaking, a study of causes leading to apathy on their part should be made and measures taken to eliminate those causes.

5.28. **Technical Examination.**—In the past various committees have examined the subject of technical examination of work by an external agency. These committees have expressed divergent views some of which are diametrically opposite in nature. The principle of technical examination has been introduced in several departments in one form or other. In some departments it is by an external agency and in others it is a part of quality control organisation of each major project. In certain cases technical examination is under the control of the head of the Department. In yet other cases technical examination has been introduced as a Vigilance measure.

5.29. The duties of the technical examination organisation cover, broadly, site check of works to ensure that these are executed in accordance with design and specifications stipulated and that payments are made on

the basis of quality and quantity of work actually carried out. In some cases scope of technical examination is enlarged to cover administration of contracts and adequacy of specifications adopted.

5.30. A department functions as a well-knit unit under the technical direction of the Head of the Organisation. Interpretations of contractual requirements and of specifications are matters in which there can be genuine differences of opinion among engineer authorities. The position would, therefore, become anomalous if an external technical examiner were to make pronouncements which were contrary to decisions given by the competent engineer authority particularly if that authority happened to be the Head of the Department. Any action which tends to weaken the authority of the Head of an organisation is fraught with grave consequences and will undermine the administrative and technical efficiency of the organisation as a whole.

5.31. During the last few years work-load has increased and there has been a great emphasis on reduction of completion periods for attaining targets. There is paucity of experienced engineers and trained craftsmen. There is a lack of experienced hands in fields in which mechanisation is essential for speedier execution or otherwise. New and untried materials are coming in the market. Supervision can, therefore, become inadequate necessitating more frequent inspections.

5.32. The remedy lies in intensifying departmental supervision by senior and experienced officers and by creating suitable inspection cells within the organisation and not by having sporadic inspections by an external agency. There should be no diffusion of authority vested in Project Head who must remain fully responsible for progress, quality and efficiency of his organisation. The internal check should be "concurrent" and not "post mortem" and may consist of inspection and laboratory control. The Construction Engineer should be primarily responsible for it. To assist him in this task a separate inspection cell under his control may be created where necessary. Vigilance should not be associated with internal technical check which should be intensive, concurrent and within the organisation. Criticism by an external organisation can even be academic in outlook particularly if it is during a "post mortem" as it is not always possible at a later date to fully visualise the various factors which may have influenced a particular decision at a particular moment even though the circumstances leading to that decision may have been placed on record at the time.

5.33. Although technical examination has resulted in recoveries from contractors in some cases, by and large such recoveries have represented a very small percentage of the total value of works carried out. As against this, contractors take into account the harassment and uncertainty of any possible recoveries resulting from technical examination which may be conducted even long after works have been completed, and increase their rates suitably while tendering for works. This increase in cost, which Government bears, is much greater than recoveries which are effected as a result of technical examination.

5.34. It may be argued that in spite of its drawbacks, the system of technical examination acts as a deterrent against malpractices and this aspect should not be ignored irrespective of the cost involved. After all several other activities of Government are also such as have to be resorted to and are not measured in terms of financial benefits. There may also

be a view that any checks which are conducted by an outside organisation will be objective. While these points of view are appreciated, it must be noted that any system which results in eroding the authority of the responsible Head of an organisation is, as pointed out earlier, fraught with grave consequences. It is not uncommon that there are sharp differences of opinion between a Chief Engineer and the Chief Technical Examiner over findings of Technical Examiners Teams, which cannot be resolved easily even by a reference to authorities at higher levels. Fear of probe by "outsiders" tends to sap the enthusiasm of the executive agency and seriously affects the working efficiency. It hinders the building up of leadership in executive officers. There is unwillingness to brave the risk of assuming responsibility, a tendency to play safe and to avoid taking decisions. These factors have a deleterious effect on efficiency, speed and economy of works.

5.35. Taking an overall view the problem, it will be seen that the advantages of the system of technical examination are far outweighed by its disadvantages. This system should, therefore, be abolished and steps taken to intensify internal supervision and quality control.

5.36. **Arbitration.**—It is seldom possible to foresee every contingency before a contract is concluded and because quality in civil engineering cannot be measured precisely but involves exercise of professional judgment, disputes arise between technologists and contractors. Disputes also arise out of ambiguities in specifications and in Schedules of Rates, lack of precision in preparation of contract documents, levy of compensation for delayed execution, works alleged to be below specification, deductions from contractor's bills as a result of observations made in Audit and in Technical Examination, faulty measurements, etc. The primary intention of settlement of disputes through the process of arbitration is to avoid delays and costs which are usually associated with litigation. If in the process of arbitration and in implementation of awards, settlement of disputes is unreasonably delayed, the purpose of arbitration is defeated. Large sums of money are thus blocked and the construction industry suffers from blockage of capital. Ultimately the cost of all arbitrations is reflected in the price Government pays for construction.

5.37. Far too many disputes are now being referred to arbitration because the Engineer/Architect believes that his decisions will be questioned and his motives wrongly attributed. He and his technical and financial advisers, therefore, find it easier to let disputes go to arbitration. The disputes are finally settled after considerable delay and cost, by an arbitrator who is generally an Engineer/Architect and has ample powers as an arbitrator under the Arbitration Act.

5.38. The solution to the problem would be to arm some "competent authorities" with powers to settle disputes up to specified amounts and having done so, to insist on those authorities exercising their powers and strictly refuse to question the exercise of these powers unless these have been obviously misused. There should be no objection to a "competent authority" taking equity into consideration in arriving at a decision on an item in dispute. A beginning may be made by empowering Chief Engineers to exercise this authority.

5.39. Contract forms in use in different Government departments provide that in the event of a dispute with a contractor, the dispute shall be referred to the sole arbitration of an engineer officer (generally of the same department) to be appointed by the authority (normally Engineer-

in-Chief or Chief Engineer) mentioned in the contract. Builders' representatives point out that an officer of the same department being saturated with departmental ideas, rules and regulations, could not be expected to take an objective view and, therefore, there should be a ban on appointment of departmental officers as arbitrators. They stress that provision for arbitration should be in accordance with the Indian Arbitration Act, and that an arbitrator must not be an employee of either party but should be an independent person. They point out that if the Indian Arbitration Act needs to be amended to make it clear that an employee of either party should not function as an arbitrator, action should be taken accordingly. They say that if parties to a contract fail to agree on a single arbitrator, joint arbitration should be resorted to.

5.40. Points of dispute with contractors being of a technical nature, it is necessary that the person who is to adjudicate on them should be an Engineer/Architect. Arbitration requires knowledge and understanding of construction practices. Appointment of an Engineer/Architect as an arbitrator is thus inevitable. Although the present arrangement does not appear to have worked unsatisfactorily, the arguments put forth by builders in favour of a change cannot be ignored. However, joint arbitration, if adopted as a matter of course, will result in delays and be also more expensive as private persons may have to be engaged as arbitrators and umpires. Government may also have to engage more counsels.

5.41. It is, therefore, considered that provision should be made in contract documents for adjudication by a single arbitrator, the arbitrator being an Engineer/Architect and acceptable to both parties. Detailed procedures to give effect to this recommendation has been worked out in the Standard Contract Form prepared by the Committee set up by the Planning Commission. Joint arbitration may be resorted to only in very rare cases.

5.42. The procedures adopted by different departments for implementation of awards are not uniform. It is recommended that a Chief Engineer be given full powers to decide whether or not an award should be implemented, after taking legal advice where he considers such a course necessary. The practice of referring awards to Government or to some other department, before these are implemented, should cease.

5.43. To avoid delays in getting funds allotted for implementing awards, lumpsum allotments should be placed at the disposal of Chief Engineers, at the beginning of each financial year, recoupment being made as and when required. This will eliminate delays which are at present inevitable in implementing awards.

5.44. **Standard Schedule of Rates.**—A Schedule of Rates is the basis for preparing estimates, for pricing tenders for different forms of contracts and for determining reasonableness of quotations submitted by contractors. Whenever any alternations, additions, omissions or substitutions have to be made in specifications, drawings, etc., forming part of a contract, a Schedule of Rates has normally to be resorted to for assessing financial implications of the deviations involved. In fact almost every form of contract is in one way or other linked with a Schedule of Rates. Therefore, to be effective, a Schedule of Rates should not only be comprehensive in so far as different items of work are concerned but should also be kept up-to-date. It should be free from ambiguities so that differences of opinion between different individuals

and authorities operating the Schedule as to rates applicable and other provisions contained therein are avoided and disputes kept to the absolute minimum, if not eliminated altogether.

5.45. At present there is a large number of Schedules varying from Department to Department and from State to State. A study of those Schedules will reveal that there are wide variation in descriptions of similar items, in units adopted, in methods of measurement and in basic data adopted in preparation of rates. Further, specifications adopted for similar items also vary. A contractor working for a particular organisation not only gets accustomed to the Schedule in use in that organisation but also to the various interpretations given by the appropriate authority in respect of different provisions of that Schedule. Therefore, when he starts operating in other organisations also in which different types of Schedules of Rates are in use, his approach to the provisions contained in those other Schedules to which he is not accustomed is conditioned by the decisions and interpretations given in respect of the schedules of the organisation in which he had been working earlier. As there is bound to be lack of uniformity in descriptions, specifications etc., adopted in Schedules of Rates prepared by different authorities, a confusion is created in the mind of the contractor. Thus when he submits quotations for work in other organisations, rates quoted by him are higher than what he would have quoted if he did not have to cover ambiguities and interpretations which he fears may be different from those he is used to. He may even hesitate to tender for works in unfamiliar organisations if sufficient time is not allowed for studying new Schedules and submitting properly worked out quotations. Under these circumstances competition in tendering ceases to be really competitive. Moreover unfamiliarity with a particular Schedule will result in disputes between the contractor and the construction agency which may otherwise have been avoided. From the point of view of construction economies, therefore, it is necessary that an All India Standard Schedule of Rates be prepared covering the following :

- (a) Standard descriptions of items in rationalised units;
- (b) Standard specifications—to be in consonance with those issued by the ISI and the Indian Roads Congress;
- (c) Prices based on standard constants of materials, Labour, tools and plant, etc.,.
- (d) Standard method of measurement.

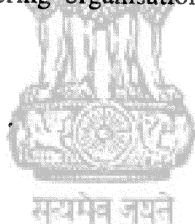
As prices vary in different parts of the country, for the Schedule to reflect market prices as closely as possible, pricing of items contained therein should be done on a zonal or other suitable basis by dividing the country into suitable regions, large towns, etc. Descriptions of items in different Standard Schedules of Rates will be the same with the exception of such items only as are peculiar to particular regions, towns, etc. All construction agencies operating in an area covered by a particular Schedule of Rates should adopt that Schedule for all contracts to be concluded for works in that area.

5.46. With a view to incorporating in the Schedules proven new techniques and materials as and when these are developed and keeping the prices up-to-date it is necessary that the Schedules be kept continually under review and necessary amendments issued thereto at suitable intervals.

5.47. Due to rapid development of the construction industry, technical know-how, construction methods and techniques have undergone a considerable change. These changes are reflected in the information which is made available by the industry, in the standards and codes issued by different organisations and by literature issued by technical institutions. Writing of specifications will, therefore, involve a study of standards, codes and literature covering latest technology issued in India and in other advanced countries. It will also involve examination of literature issued by trade in respect of various manufactured articles. Availability in the market of different types of materials complying with requirements of relevant standards will have to be ascertained and their suitability determined.

5.48. The work to be undertaken is extremely important and exhaustive and because of its special nature, has to be tackled by organising a special cell for the purpose. Because of its association with research organisations and technical institutions, both public and private, and its role in the development of new materials and techniques, and its approach to the building industry generally, the National Buildings Organisation is considered most suited for organising this set-up. That way the true national character of the Schedule will be maintained and it will develop on sound scientific lines.

5.49. The Building Projects Team (BPT) of the Committee on Plan Projects had also studied the problem of different rates existing in different departments for the same item of work in the same locality. In their report on Public Works Administration (1962) the BPT had also emphasised the need to evolve an All India Standard Schedule of Rates, priced on a zonal basis, so that such differences in rates do not occur. They had also recommended that all engineering organisations should adopt the All India Standard Schedule of Rates.



## CHAPTER VI

### ADMINISTRATIVE AND ORGANISATIONAL FACTORS

6.1. The construction component in future Plan will require a high level of developmental activity and call for urgent action to be taken to remove hold-ups and bottlenecks in the present administrative procedures. Experience in the Third Plan has indicated the need for a radical change in the existing system of Public Works Administration if the gap between targets and achievements is to be narrowed.

6.2. It has been acknowledged in almost all quarters that there are distinct possibilities of streamlining the administration of construction departments which would result in the achievement of speed, efficiency and economy. A number of committees were constituted by different Central Ministries and the Planning Commission to examine the working of the existing administrative machinery of these departments and to suggest steps to streamline it. Though these committees have made positive recommendations, most of these recommendations remain unimplemented. Unless there is a dynamic approach and bold steps are taken, it is doubtful whether the present system of administration will permit of physical targets to be set forth in the future Plans being achieved.

6.3. **Executive Pattern to replace Secretariat System.**—In the present system, Technical Head of a construction department is subordinate to secretary to Government in that department. Whereas the Head of the department is made responsible for producing results and is the motive force behind the implementation of the Plan programmes, he is not given due recognition. The system leads to a considerable time of technologists being wasted in explaining technical matters to non-technical Secretariat. Often technologists have to discuss schemes with Under Secretaries, Deputy Secretaries and Secretaries before these are put up to those who are responsible for taking decisions and for laying down policies. As the technologist does not normally have direct access to the policy making head, his views are diluted and modified in the process.

6.4. Instead of providing relief to the Technical Head, the present system adds to his work and he is left with insufficient time to ensure efficient functioning of the department. The system causes irritation and frustration even among senior technologists with the result that they lose initiative and in due course this attitude is reflected in the working of lower functionaries in the department. This is a distressing situation and has to be remedied. Any reform or re-organisation to be effective must recognise the fact that the person who translates Government's policies and programmes into action is given full authority to do so and to get the best out of his subordinates.

6.5. The Building Projects Team of the Committee on Plan Projects have made a specific study of the subject of administrative and organisational factors in relation to construction departments of Governments. It has been brought out in their Report that the present system provides for unnecessary checks and restraints which lead to lack of faith and confidence and to a marked tendency to avoid taking decisions. It does not permit of

bold actions and trials of new ideas and of advances in science and technology. Planning and research involve risk. These also involve expenditure which may not always produce direct results. These factors have, however, to be accepted if the country has to make progress.

6.6. In order to achieve economy, efficiency and speed in construction and to ensure that adequate authority to discharge their responsibilities is given to Heads of construction departments, it is essential that the present system of Public Works Administration be abolished and a system based on an executive pattern be introduced so that both responsibility and authority vest in the Head of the department and his senior technical colleagues.

**6.7. Ministry of Construction.**—Although construction in various forms accounts for a heavy development outlay, there is no single organisation charged with the responsibility of organising, assisting and promoting the construction industry and generally taking steps to ensure proper utilisation of available resources and of modernisation of construction techniques, Communication of technical information, collection and utilisation of statistics, intensification of research and its application to industry, experimentation and introduction of new techniques and various other aspects of the construction industry are at present dealt with piece-meal by different organisations. Due to lack of norms and standards and use of outmoded criteria, designs adopted are not always economical. Technical manpower recruitment, their training (pre-service and in-service) and proper utilisation, setting up of a suitably staffed central design cell with appropriate expertise, affording of assistance in speedy and economical execution of construction financed from public funds popularisation and development of management aids and services, development of new materials, setting up of equipment pools and of Construction Finance Corporation, registration of contractors, organising the business aspects of construction industry, ensuring that errors committed in earlier projects are not repeated in subsequent ones, etc. would indicate a definite requirement for a Central Authority which will attend to these tasks and to others which have been outlined earlier in this Report. This aim could be achieved by reorganising the existing Ministry of Works suitably into a Central Ministry of Construction. The role of the reorganised Ministry should broadly be to assist the Construction Industry as a whole in the wide range of problems which concern it, to encourage the development of new techniques and materials, to ensure proper utilisation of technical manpower, to build up expertise and to arrange for economical and speedy execution of works financed by the Central Government.

6.8. Autonomy of various public sector undertakings should not be interfered with. Their construction should, however, be done with the technical assistance of the proposed reorganised Ministry. Large undertakings should continue to have separate Chief Engineers (appointed by the Construction Ministry) under the administrative control of their General Managers but technical guidance should be provided by the proposed Ministry which should also lay down uniform and economic standards & specifications and disseminate up-to-date technical knowledge and information. Coordination of construction activities of different public sector undertakings will thus be achieved through the medium of the Central Ministry.

6.9. Economy in construction does not depend merely on lowering of scales and specifications. Construction is a complicated affair involving materials, human-beings and management. Improper management, unsatisfactory human relations, discontented staff, irregular and uncoordinated supply of materials, etc., may more than offset all attempts at economy. The Central Ministry would assist in proper attention being devoted to all these aspects eventually leading to economy in construction.

6.10. Construction staff of public sector undertakings should be borne on a regular cadre operated by the Central Ministry so that individuals are assured continuity of service and surplus technical staff is not discharged on completion of works but is transferred from one undertaking to another or elsewhere, as necessary, and the experience gained is properly utilised.

6.11. It may be argued that the formation of the Central Ministry of Construction will result in over-centralisation and doubts may be expressed about the ability of such a single Ministry to deliver the goods. The size of an organisation is not what matters. What really matters is the manner in which the organisation functions. If the set up is so framed that there is maximum centralisation of policy making and maximum decentralisation of executive authority, the organisation should be able to cope with any amount of work. Besides, a large organisation is better equipped to address itself to specialisation in different fields. The intention is that this Ministry should be so organised that it can cope with the task of developing the construction industry as a whole and attend to Central Government's programme of works efficiently.

Another question which may arise is whether it is the intention to amalgamate all organisations, which have developed specialisation in particular fields in the existing public sector undertakings, with the proposed Ministry of Construction. The aim is to do away with a number of planning and design organisations which are created on an *ad-hoc* basis for carrying out civil engineering works connected with individual projects. Continuity of work load over a period of, say, 20 years is not available to these organisations and the specialised knowledge built up is wasted. It has been suggested that a well equipped Central Planning and Design office be set up in the proposed Ministry of Construction. This set-up being sufficiently large will be able to build up separate units or teams within its field to plan and design organisations which have been built up in the public sector under-industry. As this organisation will be entrusted with work on an All India basis continuity of work load could be ensured. At the same time, it is not the intention to immediately disturb the existing large planning and design organisations which have been built up in the public sector undertakings in the fields of iron & steel, fertilisers and petroleum as these organisations have built up expertise to plan, design and execute civil engineering works needed for these industries. But the aim will be to maintain close liaison between these organisations & Central Ministry of Construction and gradually bring the civil engineering sections of these organisations into the fold of the Construction Ministry. The formation of a common cadre of technical personnel should, however, be taken up immediately. Interchange of technical personnel between the proposed Ministry and public sector undertakings should lead to cross-fertilisation of ideas and general improvement in standards.

6.12. The procedure for liaison between the proposed Ministry of Construction on the one hand and the Council of Scientific and Industrial Research and the National Laboratories on the other, should be laid down so that results of research in construction techniques are utilised and the problems encountered in the field are fed back to the laboratories for further research and study. The proposed planning and design office in the Ministry of Construction has to play a pivotal role in this matter. As this office will be responsible for planning and designing large and important projects, decisions with regard to adoption of innovations in construction techniques or materials developed by research, could be taken at the highest level and incorporated in projects from the initial stages. It is by utilisation of results of research in large projects that significant economies will be achieved and confidence built up for general adoption of these results in the country. The Central Planning and Design office will have a better perspective of the country's current construction activities and its future programmes. This office will, therefore be able to identify areas in which research is urgently required for solving problems of construction and which would contribute towards larger economies. National Laboratories are not in a position to take up research simultaneously on all problems which are thrown up by the various construction agencies in the country. The Central Planning and Design office will be an appropriate agency to scrutinise these problems and lay down priorities so that maximum returns are achieved within available resources.

6.13. The Ministry of Construction will also be responsible for coordinating the problems of the construction industry with the activities of National Laboratories in the field of Civil Engineering. Adoption by the industry of new construction techniques and materials developed by these laboratories and feed back of important problems facing the industry to the laboratories for investigation could be greatly facilitated. The proposed Ministry of Construction would, it is considered, greatly improve mutual coordination in the activities of the National Laboratories, construction departments and the construction industry.

6.14. The Construction Ministry should be so constituted as to give the executive head (a Director General of Construction) adequate authority and responsibility for taking decisions on technical matters and for advising Government on matters of construction policy. It should have field organisations on a zonal basis depending on work load so that executions of works which are entrusted to the Ministry is undertaken by these field units. These set-ups will have full authority to exercise initiative within the broad-framework of the policies laid down by the Central Organisation. Work pertaining to Defence, Railways and Irrigation & Power should, however, continue to be dealt with as at present as these departments have very large civil engineering organisations of their own and their work is of a specialised nature. The pooled scientific know-how of the Ministry of Construction should however, be available to them.

6.15. The constitution of the set-up in the Ministry which should deal with the various tasks enumerated above is indicated in Appendix-C.

6.16. **Construction Organisation in States.**—Generally, in every State, there are three branches of engineering viz. Irrigation, Buildings & Roads, and Public Health and each branch has one or more officer of the rank of Chief Engineer. If in any branch, the number of Chief Engineers is more

than one, the seniormost Chief Engineer or the selected Chief Engineer should be designated as Principal Secretary and the other Chief Engineers as Secretaries. The Chief Engineer functioning as the Principal Secretary should be incharge of establishment and of coordinating policy within the branch. All Chief Engineers of a branch should act as a Board for formulation of policies for the branch and for taking decisions on technical schemes above a certain value, say, Rs. 2 crores, for which Chief Engineers will have joint responsibility. The Chief-Engineer functioning as the Principal Secretary should be the Chairman of the Board.

**6.17. Advisory Board for State Development.**—There should be machinery in the States for pooling technical data and experiences with a view to drawing up an integrated plan of development which would include judicious allotment of priorities, assembly of resources with reference to needs of a project and the drawing up of realistic programmes of execution. Each State should set up a high powered body of Engineers, Architects and other technologists charged with the responsibility of coordinating all construction activities. The Board would keep under review all problems of a technical nature and its Chairman will have the responsibility of tendering advice to the State Cabinet on important technical and allied matters.

**6.18.** The Chairman of the Advisory Board should be the Chief Technical Adviser to Government and should have necessary technical staff to assist him. The staff organisation might consist of Directors of planning and coordination, of recruitment and training, of construction equipment (with a suitable set up on a zonal basis for looking after mechanical equipment), of the construction materials, of work study, research and information.

**6.19.** This problem was also studied by the Building Projects Team of the Committee on Plan Projects of the Planning Commission and in their Report on Public Works Administration the Team made similar recommendations.

**6.20. Accounting and Audit.**—Accounts rules for public works were formulated in 1908 in the form of a compilation called "Public Works Departments Code". These were modified by Govt. of India in 1918. The existing pattern retains its fundamentals from that year. The system of accounting envisaged in these rules was intended to suit the level of construction activity that was prevalent in earlier days. With the manifold increase in the construction activity, these accounting procedures and rules have become out of date and cumbersome. The present system of accounting offsets the efficiency of execution of public works and requires to be modified to suit the present day conditions.

**6.21.** Considerable rationalisation of accounting procedures for public works with a view to eliminating interferences, delays, etc. is called for. The present rules and procedures should be modified so that it is easier for a Project authority or Head of an organisation to work efficiently. Simplification of accounts rules will also result in economy in overhead expenses.

**6.22.** The Building Projects Team of the Committee on Plan Projects (Planning Commission) have, in their Report on Public Works Administration, made certain recommendations after making a comparative study

of the existing system of accounting procedures of vogue in different departments. The Committee on Administration which had been appointed by the Central Cabinet for promoting administrative efficiency had set up a Working Group for simplification of Public Works Accounts Code. The Report of this Working Group contains a number of suggestions for simplifying the existing procedures within the existing frame work in the Account Code of the Central Public Works Department. The Working Group have also suggested that other construction departments like M.E.S. and State P.W.Ds. may consider whether they can profitably review their procedures in the light of the recommendations made in their Report. The recommendations contained in the two aforementioned Reports need to be implemented where not already done.

6.23. In the existing pattern of Public Works Departments, an Executive Engineer/Divisional Engineer is the primary disbursing officer. Account are compiled under his supervision and are forwarded to the Accountant General for audit and incorporation in the General accounts. The Accountant General is vested with dual functions of accounts and auditing. Chief Engineer's office also compiles figures of expenditure from returns obtained from various divisions in order to facilitate effective control over expenditure. Apart from the duplication of work involved in following this procedure, considerable time and effort are wasted in reconciliation of figures in the accounts kept in Chief Engineer's office with those maintained in the Accountant General's office. Preparation of Appropriation Accounts is delayed and involves avoidable correspondence and office work.

6.24. To obviate these it is advisable to separate accounting from audit, to relieve the Accountant General of the responsibility of accounting, and to keep accounting and primary audit with Chief Engineers. Auditing by the Accounting General might preferably be done through audit parties visiting divisional offices and offices of Chief Engineers as often as necessary. This system will reduce time and energy spent on correspondence and on queries which arise out of periodical returns which are normally submitted to the Accountant General while initial documents are retained in divisional office.

6.25. A controller of Accounts with suitable staff should be placed under Chief Engineer and made responsible for compilation of accounts and for rendering advice to Chief Engineer on financial matters. The executive should be in control of accounts staff if unnecessary delays are to be avoided and works executed speedily, in spite of any minor disadvantages which the system may entail.

6.26. At present promotions, transfers, etc., of Divisional Accountants are controlled by the Accountant General. Administrative control over Accountant is, however, exercised by the Executive Engineer in whose office the Accountant functions. This dual control, which is not conducive to efficiency, will be eliminated when accounting is separated from audit, and all personnel matters pertaining to accounts staff are dealt with by the establishment branch of the Chief Engineer's office.

6.27. The responsibility for maintaining accounts should primarily be vested in the executive. Executive Engineers, Superintending Engineers and Chief Engineers should have accounts officers of appropriate rank to help and advise executive officers. The Controller of Accounts on the staff

of the Chief Engineer would be in overall control of all accounting matters and would issue necessary instructions on behalf of the Chief Engineer on policy and other matters relating to accounts.

6.28. All payments should be made by executive Engineer after technical, arithmetical and primary audit checks have been exercised in his office. Pre-payment audit by an external agency should be done away with. Recovery can be effected from a contractor in accordance with contract terms if any over payment is detected in post-payment audit by external audit parties. Any risk involved in adopting this system will be more than compensated by reduction in tendered rates resulting from speedier payment, and is worth taking.

6.29. **Cost Accounting Cells.**—A cost accounting cell should be created in every important project. Scientific procedures should be laid down for collecting field data in respect of cost concurrently with the construction of project. A cost accounting cell should also be set up in every construction department in Chief Engineer's office. It should do costing of works systematically and should help planning and work study cells which have been recommended to be set up in large projects and departments. The data obtained by cost accounting cells should also be fed to cells working on the preparation of Standard Schedules of Rates and for keeping these up-to-date.

6.30. **Budgetary Provision.**—Once a project with a time schedule is sanctioned, it is necessary that there should be no material change in construction programme. Various hindrances which impede progress but which could be avoided by detailed studies before design and construction are undertaken have been dealt with in previous chapters. Sometimes budgetary provisions made from year to year are substantially lower than the funds required for an optimum programme of construction. Though it is realised that urgent financial needs and other unforeseen circumstances do sometimes make unusual demands on the available financial resources of the country, it should be appreciated that any dislocation in continuity of execution results either in expensive equipment and staff being ungainfully employed or their partial or full disbandment. It should be obvious that equipment and staff once disbanded are not easy to reassemble. Starving a project of the requisite funds would, therefore, lead to delays and increase in costs. It may also lead to financial claims from contractors and suppliers besides causing deterioration of materials collected. The inertia created by slowing down or stoppage of planned construction schedule is another serious consequence which further affects costs. In short, budgetary planning and continuity of funds are as important as realistic and optimum schedule of construction and should receive full consideration. It is, therefore, recommended that funds for construction of important projects should be allocated over a long period and not by annual budgetary provision.

6.31. **Organisational Pattern for Dissemination of Results of Research and for Development.**—A well equipped and suitably manned Research and Development Organisation for application of results of research to construction, standardisation, development of materials, socio-economic studies, training and information is essential. Some of these functions are at present being performed by the National Buildings Organisation.

6.32. In addition to the functions which are being performed by the National Buildings Organisation as constituted at present, Development Groups to evolve standard design for works of repetitive nature, based on up-to-date technical data, have to be established. This will ensure uniformity in design conforming to functional requirements and result in economy by eliminating waste.

6.33. Establishment of a Building Materials Assessment and Development Cell in every State has been recommended. These Cells will be responsible for making a fair assessment of requirements of construction materials and plan their increased production and distribution. Such a step is expected to stabilise prices of materials which have been markedly rising during the last few years. As materials account for two thirds of cost of construction, stabilisation of their prices will result in economy in construction costs. Establishment of a Building Materials Assessment and Development Cell at the Centre would also be desirable to coordinate the efforts of different States and to lay down methodology and norms. The National Buildings Organisation is considered a suitable agency for the purpose.

6.34. Preparation of an All India Standard Schedule of Rates will contribute largely towards bringing uniformity among different construction departments in preparation of estimates, descriptions of items, units adopted and in methods of measurement, and in basic data adopted in preparation of rates. At present a large number of such Schedules of Rates exists and the wide variations in descriptions of items and basic data adopted in preparation of rates create confusion in the minds of contractors working simultaneously in different departments. Contractors, therefore, push up prices to cater for "assumed" liabilities. Preparation and adoption of an All India Standard Schedule of Rates priced on a zonal or other suitable basis is, therefore, essential. The National Buildings Organisation has been requested to prepare such a schedule to have it suitably priced and to revise it periodically so as to keep it up-to-date.

6.35. In the past Plan years, a large amount of construction has been carried out in various fields. The experience gained and the expertise built up by carrying out different projects have generally been confined to a small number of engineers associated with these works. There is a necessity to disseminate technical information and data which have become available so that this information may be advantageously utilised by technologists all over the country in future works. The National Buildings Organisation should act as a "clearing house" for dissemination and exchange of technical information. It has to intensify work on experimental and demonstration housing in collaboration with research organisations. Display and Information Centres have to be established in different parts of the country. Refresher courses have to be arranged on important technical matters for technologists engaged in the industry and work study facilities have to be provided.

6.36. In view of the foregoing tasks which the National Buildings Organisation is expected to perform, it is essential that it be suitably strengthened and reorganised.

6.37. The Standing Committee of the National Buildings Organisation appointed a Sub-committee in 1965 under the Chairmanship of Maj. Gen. Harkirat Singh to review the existing set-up of the organisation and to



## CHAPTER VII

### MOTIVATION, TRAINING AND PUBLICITY

7.1. **Motivation.**—Motivation and incentives are largely concerned with psychological and human factors which have to be taken into account to get the best out of an individual. Incentives present an appropriate device through which motivation may be provided but they cannot, by themselves, meet the present day challenge where many complex human problems are involved.

7.2. The factors which create a proper climate for everyone concerned to put in his best are :

- (a) Everyone should feel that he is an important member of a group engaged in a useful national activity;
- (b) A person under whom an individual is working should appear to him to be a capable and efficient leader towards whom he would naturally feel a sense of respect;
- (c) An individual feels that his work is being appreciated and, in exceptional cases, even being materially rewarded;
- (d) Any delay or failure to get recognition is in all probability an indication that he should strive harder and not feel frustrated.

Although there are other human factors which go towards creating the right climate, the recommendations in this regard have been limited to such concrete steps as would require administrative action. To produce the right climate, many other things will have to be done including careful selection or even training of leaders to ensure that they possess the skill required to deal with human material.

7.3. In the present system of working of public services, supremacy of administrative personnel over technical personnel acts as a disincentive where exercise of initiative by the latter is concerned. Terms and conditions of service of engineering personnel, architects and other technologists in Public Works Departments and Public Sector Undertakings need be reviewed and appropriately modified. Control of all technical departments from the lowest level to the highest level should be entirely in technical hands both in the States and at the Centre.

7.4. The system which permits assessment of capabilities of technical personnel by officers of the administrative cadre should be abolished. (In some States annual confidential reports about capabilities of Divisional Engineers/Executive Engineers are written by Collectors/Deputy Commissioners) Officers of the administrative cadre cannot properly assess capabilities of technical personnel as work done by the latter is largely technical in nature. Capabilities and performance of technical personnel should be judged by their superior technical officers only.

7.5. Salary and status of engineers, architects and technologists in Class I service are at present generally lower than those of officers of the Indian Administrative Service for equivalent length of service. It is essential that this disparity be removed and technologists given their due place. Their pay and status should not be lower than of those in the Administrative Services for equivalent length of service. Formation of the Indian Service of Engineers should be speeded up as this will, to a certain extent, remove the disparities that exist at present.

7.6. Apart from ameliorating the conditions which dampen the initiative of engineers, architects and builders, it is necessary to institute positive incentives as a mark of recognition for outstanding achievements. A technologist who during his employment acquires additional qualifications or makes an outstanding contribution should be appropriately rewarded by the Department or the project with which he is concerned. Whenever an engineer or a team of co-workers show higher efficiency which results in significant economies they should be suitably rewarded. Such rewards may be in the form of advance increments, accelerated promotion, cash awards, certificates of merit, etc. Departmental (Technical) Head should be the competent authority to recognise good achievement and reward it suitably.

7.7. To recognise work of an exceptional order incentives should be instituted at the national level. National awards should reward individuals or groups who have contributed towards achieving construction economy of an exceptional order. The amount has to be necessarily high to stimulate intensive effort. A broad of judges consisting of eminent technologists should make the selection every year from proposals received from all over India. Awards should be given in deserving cases only and not as a matter of course.

7.8. Extreme degree of vigilance exercised in recent years by the Special Police Establishment, Vigilance Departments and other similar agencies and checks exercised by the Chief Technical Examiner, though useful to some extent, act as a disincentive to serious and sincere workers even at senior levels resulting in loss of initiative. A review of these measures is considered essential.

As the tone of efficiency in a department is set by its Head, it is essential that in selecting the Head, integrity should be one of the major considerations. Having selected the Head, full confidence should be placed in him as otherwise his initiative, drive and enthusiasm are dampened. The following steps should provide an effective alternative to present methods for putting down corruption and increasing efficiency :

- (a) The responsibility for proper and efficient working of a Department or a project should be placed on the Head of the Department/Project giving him ample powers over staff under him;
- (b) Head of a Department or a Project should as a rule be free to deal with all cases of corruption or other malpractices within the Department/Project. Outside agencies concerned with vigilance should remain at the disposal of the Head for conducting such investigations as the Head may wish them to carry out;

- (c) Quality control mechanism within the Department/Project should be strengthened by establishing quality control units responsible directly to the Head.

**7.9. Training.**—One important aspect which is generally overlooked by construction departments in the country is training of engineering personnel, especially the officer cadre. This has indirectly resulted in a gradual decline in efficiency. It is normally assumed that when young officers enter service, they do not need any training to become conversant with departmental rules and procedures and that those who have been in service for some years are up-to-date in their technical knowledge. Both these assumptions are incorrect. In service training is necessary if efficiency has to be maintained.

7.10. Training of technical officers of construction services may be sub-divided into the following two broad categories :

- (a) soon after recruitment,
- (b) after gaining experience.

These two aspects of training are different from each other in approach and intensity but are equally important. The responsibility for imparting training to officers in either of these two categories should be borne by the organisation(s) to which officers belong. Leaving it to individuals to achieve proficiency through experience and personal efforts is not the best way to encourage efficiency and much better results will be obtained if training is imparted to officers soon after they enter service and refresher and specialised courses are arranged at frequent intervals thereafter. The amount spent on training will be more than compensated by economy achieved in construction costs.

7.11. Recruitment to Public Works Departments and Public Sector Undertakings is normally made at the Assistant Engineer/Assistant Executive Engineer level and at corresponding levels in other categories of technologists. Generally, graduates in technological disciplines without any experience or with one or two years experience, are selected for such posts. An officer of this type is normally placed in direct charge of a sub-division which is the primary unit of any construction service. Although such an officer has a sound theoretical background of the particular discipline to which he belongs, he is not conversant with the many administrative and other departmental procedures which are associated with the execution of works. As works procedures vary from department to department, an officer newly recruited to a department cannot be expected to be conversant with its procedures though he may have worked for one or two years in another department.

7.12. Imparting of training in works procedures is obviously not practicable in an educational institution. It is, therefore, necessary that construction departments of the States and at the Centre organise suitable training courses for all newly recruited technical officers.

7.13. The training should include lectures, visits to projects/construction sites and attachment to construction units in the field and to associated administrative and accounts offices. The scope of training should,

*inter alia*, cover instruction on departmental organisation, procedures administration, accounts procedure, works accounting & budget; quantity surveying & contract procedure; stores management and inventory control; personnel management; and site management, construction techniques and use of equipment.

There is nothing new in the proposal to train engineers and other technical officers on recruitment. In fact this system has already been adopted by the Railways. Established industries in the private and public sectors, the Indian Administrative Service and other Services have a regular programme for training newly recruited young officers prior to their being assigned independent roles. The system of initial training has not hitherto been generally adopted in construction services owing perhaps to the need for placing technical personnel in position immediately on recruitment. However, a stage has now been reached when systematic training to newly recruited engineer and other technical officers, before being assigned independent charge of works, should be insisted upon in the interest of efficiency and economy.

7.14. Engineers, architects and other technologists who have served continually for a few years in a Government department become "routine minded" and tend to lose dynamic and progressive approach to the fields of science and technology. They tend to lose touch with the latest, technological developments owing to absence of facilities to keep themselves abreast of modern developments in the country and abroad. Study leave to attend refresher courses and specialised courses is not easily sanctioned due to shortage of experienced technical personnel. Often those who are able to attend special training courses conducted by universities/institutions, have to provide the requisite funds from their own resources. These factors act as disincentives to serving engineers, architects and other technologists towards acquiring additional qualifications/training.

7.15. Engineers, architects and other technologists in Government employment should be encouraged to attend refresher courses, advanced courses, specialised courses, etc. to enable them to keep abreast of rapidly developing technology in the field of construction and to acquire post-graduate qualifications.

Refresher courses should cover instructions in a wide range of subjects connected with techniques of construction and construction management and should give a clear picture of modern developments in various fields. These courses are intended to apprise practising engineers and architects of the latest developments in construction technology and their application with a view to achieving efficiency and economy. As far as possible every technologist should be able to attend such courses periodically (say, every five years).

Advanced course should be limited to subjects with which design and development are inter-linked *viz.* advanced structural analysis, structural designs, computer method of structural analysis, soil mechanics, concrete technology, prestressed concrete, etc. Engineers and other technologists who have an aptitude for design and development should be encouraged to attend advanced courses in the country and abroad and given the necessary facilities for the purpose.

Specialised courses should lay stress on construction technology of a special nature, viz., foundation engineering, industrialised methods of building construction, welding technology, use of special construction plant and machinery, air conditioning, illumination engineering, etc. Individuals with necessary qualifications and aptitude should be selected and trained so that expertise in specialised branches is built up.

7.16. Quantity surveying is a discipline which has not received due attention in the country. In order that fairly accurate financial implications of a commitment are known before it is made, preparation of bills of quantities for a work which is required to be executed is necessary. This in turn necessitates preparation of drawings, specifications and other requisite details. Contracts can then be concluded on a lump-sum basis, work is executed more smoothly and payment of contractor's bills is comparatively speedier. Civil engineers should, therefore, be given special training in quantity surveying.

7.17. In all construction departments, Assistant Executive Engineer/ Assistant Engineer is assisted by subordinate supervisory staff. This staff is expected to perform a series of routine checks and tests. As improved construction techniques are being introduced, it is necessary to put supervisory staff through training courses and refresher courses. Such courses should lay stress on practical aspects of construction, methods of constructing tests and precautions to obtain good workmanship. The courses should cover subjects like welding technology, concrete technology, etc. Without adequate training, supervisory staff engaged on large construction works will acquire experience in modern techniques by trial and error only, which is not a satisfactory method of dealing with the problem.

7.18. Till the recent past most skills in India had been passed down from father to son as indeed was the case in most other parts of the world till a few decades ago. With the development of increased demand for skilled workers and evolution of new technologies requiring newer and more sophisticated skills coupled with an urge to boost productivity, systematic training of workers has acquired a degree of importance in modern economies, which India has had to recognise in early stages of planning. With the increased pace of development training of skilled workers in India will have to be given greater attention commensurate with our future needs.

Trade	No. of seats sanctioned	Seats introduced	Percentage introduced
1. Building constructor*	224	176	88
2. Carpenter . . . . .	7,290	6,288	86
3. Blacksmith . . . . .	5,468	4,688	86
4. Plumber . . . . .	1,248	1,040	83
5. Sheet Metal Worker . . . . .	4,288	3,632	85
6. Welder (gas and electric) . . . . .	8,188	7,640	93
7. Wireman . . . . .	8,528	7,656	90
8. Electrician . . . . .	13,032	12,048	92
	48,266	43,168	89

\*Includes the trades of brick-layer, stone-layer, concretor, plasterers and floor-layer. The period of training at present is 18 months for every trade, but it is proposed to change this in the Fourth Five Year Plan when the period will be reduced to 12 months for some trades and increased to 24 months for others.

7.19. Out of 30 Engineering and 22 non-Engineering trades under the Directorate General of Employment and Training of the Ministry of Labour and Employment, training is imparted in 8 trades pertaining to the construction industry and the capacities created in these trades up to the end of Third Five Year Plan are given below :

7.20. The following may be considered as essential construction trades :—

Brick-layer	Riveter
Concretor	Plumber
Stonemason	Painter
Plasterer	Decorator
Floor-layer	*Welder
Blacksmith (reinforced concrete)	*Carpenter (Building & furniture)
Steel fabricator	*Wireman
Fitter (Structural)	*Draftsman

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\*Trainees from these trades are liable to migrate to industries other than construction.

7.21. The Department of Labour & Employment should continually keep under review the requirements of the building construction trades in the country which in the past had not been given the importance these deserved. In the light of the present needs of the country, the existing facilities in respect of these trades should be considerably expanded.

7.22. Welding is being more commonly used in construction as a result of implementation of Indian Standards which aim at effecting economy in steel. The demand for qualified welders would consequently increase considerably. The existing capacity for training welders in India is of the order of about 7,600 a year against the sanctioned capacity of 8,200. On the basis, however, of the planned production of steel plates, sheets, strips, structural steel, etc. it has been estimated that the requirement of additional welders during the Fourth Plan period would be of the order of about 80,000 which would call for an addition of 16,000 welders per year. The present plans for training welders would, therefore, have to be considerably expanded to a level well above 16,000 per year so as to always have an adequate number available for active employment.

7.23. For other trades similar estimates will have to be made and adjusted from time to time. A measure of flexibility would, therefore, be advisable in creating and expanding facilities for training.

7.24. In the context of the present shortage of construction timber in the country efforts are being made to achieve economy and efficiency in its use and to encourage use of secondary species after seasoning and treatment. Present methods of extracting timber from forests are outdated and wasteful. To minimise waste in felling, conversion and transportation and to increase output, forest departments are being urged to modernise their logging methods by introducing improved basic logging tools and mechanised equipment. The Study Group in its study on Productivity in the Timber Industry has recommended that every Forest Department should have a qualified logging officer to train forest

personnel in charge of departmental operations as also contractors' men, in felling, fashioning and extraction of timber. These logging officers should give demonstrations to workers engaged in timber extraction and in the use of modern logging tools and equipment. Labour employed on conversion and transportation of timber should be given training in the use of modern equipment.

7.25. There is need for imparting "in-service" training in modern timber engineering techniques to personnel employed on supervision of building construction in the public sector. Microscopic identification of timbers should be given special attention during the period of training.

7.26. Mechanisation is being gradually introduced in the construction industry in the country to achieve speed and quality. With the gradual increase in construction equipment and machinery, availability of well trained operators and technicians to carry out servicing and repairs has not kept pace with it. Many observations have been made about the under-utilisation of heavy construction equipment. One of the reasons for such a situation is the shortage of suitably trained operating staff and technicians capable of carry out servicing and repairs. For this purpose training centres should be set up by the Ministry of Labour & Employment. A scheme may also be introduced to train apprentices in the proposed Equipment Pools when set up.

7.27. As it is not possible for any one person to have detailed knowledge of all trades, master craftsmen have to be employed for different trades in order to obtain work of good quality. An organisation of master craftsman has, therefore, to be built up. In the old days craftsmanship was generally hereditary and hereditary master craftsmen were available for different trades. Now the demand is so heavy that sufficient master craftsmen of this category are not forthcoming. It is, therefore, necessary to devise suitable special courses to turn out master craftsmen. Intelligent craftsmen with potential qualities of leadership should be selected and trained for the purpose. These courses should, *inter alia*, include demonstrations, intensive practice in the skills concerned and organisational methods to train craftsmen so that after training master craftsmen are able to lead a group of craftsmen. As master craftsmen are generally persons who have risen from ranks, training should be given in local language.

7.28. In certain trades, the existing branches of specialisation have to be modified to suit field practice. For instance, present training courses for blacksmiths should *inter alia* cover specialisation in either structural steel work or steel reinforcement or ducting for air-conditioning, etc. Such specialisation will lead to higher proficiency and improved workmanship.

7.29. In addition to the training centres organised by the Ministry of Labour, training of craftsmen should be provided for in every large project. Expenditure on training could be absorbed in the project outlay. Such training centres were organised at the Bhakra Nangal and Farraka Barrage Projects. Experience gained in these projects could be useful while planning training centres in future projects.

7.30. Public Works Departments at the Centre and in the States should also devote serious attention to training of craftsmen. This may require some additional expenditure but it will more than pay for itself as it will result in better quality.

7.31. Those workers who are already skilled should be provided facilities for obtaining trade certificates without having to undergo a formal course of training and without undue formalities. The responsibility for recognising competence of an Institution to issue certificates should be vested in a Central Body such as the Labour Ministry.

7.32. Training of apprentices by large employers has become mandatory since the enactment of Apprentices Act 1961 by the Central Government. Although Training in a few building Trades has, *inter alia*, been covered in the operation of the Act, not much progress has been made in this direction in the construction industry and in construction departments. To enforce implementation of the provisions of this Act, suitable clauses should be introduced in contract forms in use in construction departments. (A suitable clause has been incorporated in the Standard Contract Form which has been prepared by the Committee set up by the Planning Commission). Training of apprentices in building trades should be insisted upon by construction departments, especially on large projects.

7.33. **Publicity.**—Wide publicity to achievements resulting in significant economies is essential. It is necessary to bring to the attention of engineers, architects and builders important technical information and data having a bearing on construction economy. A large volume of such information is already available in the country as a result of past researches and construction experience. Due to the availability of a large number of foreign journals in the field of engineering, Indian engineers, architects and builders are more aware of the progress made in foreign countries than what is being achieved in this country. Often conditions prevailing in foreign countries are not fully applicable in India. Difficulties and problems which are met with in India are peculiar to our own local conditions. It is, therefore, necessary to disseminate knowledge pertaining to the manner in which these difficulties were surmounted. This fact does not at present appear to be adequately appreciated in authoritative quarters and the situation will have to undergo a significant change if substantial results are to be achieved. The courses of action recommended have been brought out in the ensuing paragraphs.

7.34. The National Buildings Organisation, the Indian Standards Institution, the Central Water & Power Commission, the Central Board of Irrigation & Power, the Indian Roads Congress and other similar organisations should extend their facilities to serve as clearing houses for dissemination of technical information in their respective fields. They should not only be responsible for collecting and making available such information to technologists on demand but should themselves publicise it through all channels open to them.

All engineering project organisations should publish detailed reports of all matters connected with the achievement of efficiency and economy obtained through their construction operations, which could be of use to technologists engaged elsewhere in similar activities. The responsibility for writing such reports should not be left diffused but should be placed squarely on the chief executive of the project. These reports should not be treated as of less importance than the project itself. (Numerous pamphlets are issued by project authorities as occasions of visits of dignitaries but none of these cater to the needs of technologists interested in learning lessons from difficulties met with during the course of construction, how these were surmounted and other unusual features). Specific provision should be made in the project for employment of adequate staff right from the beginning to help the chief executive in this task.

7.35. There is a need to present original Indian contributions to technology in an impressive and readable manner. An independent journal on "Engineering Construction Economy" should be started, which should be produced attractively and made available to all concerned at a reasonable price. It should cover all sectors of construction viz. roads, railways, waterways, multi-purpose projects, public buildings, private house construction, warehouses, factories, etc. The aims of the journal should be to :

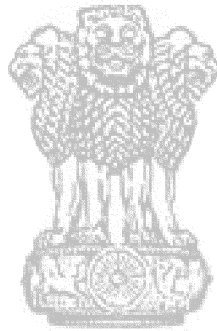
- (a) promote reading habit among Indian engineers, architects and builders;
- (b) publish articles on better training, better methodology, better quality control, greater economy, higher productivity, standardisation, etc.
- (c) bring to the notice of the engineering profession achievements in various construction projects in India, which often lie buried in the archives of these projects;
- (d) publish case histories of economies in construction achieved in other countries;
- (e) have, if possible, an abstracting service limited to select items relating to construction economy.

The management of the proposed journal should be in the hands of a person with initiative and drive. Expenditure incurred on the publication of the journal may be subsidised, if necessary, by Government in the early stages. The journal will be successful only if a person of the right calibre is induced to take charge of it.

7.36. Government agencies concerned publicity such as the Press Information Bureau and the All India Radio should be utilised to highlight construction economies achieved in different projects and give prominence to names of individuals responsible for bringing these about.

7.37. **Requirement of a Policy to Encourage Technical Talent.**—Although it has been declared from many platforms that technologists have to play a vital role in the country's programme of planned development, the existing conditions of their service do not contribute towards giving them encouragement to give of their best. An important observation which has been made in a recent address by the Deputy Chairman, Planning Commission, is "One feature of the situation which is prevalent generally may, however, be noted. This is a legacy of British colonial rule which by the very nature of its operation made the general administrator the dominant figure in all governmental activity. Since independence and even after development planning has become important, little attention has been paid to the necessary modification of this feature of our administrative structure and operations." The fact that the existing system is outdated and requires immediate modification is also evident from the general sense of frustration and lack of initiative which prevail even among leading technologists in the country. The flow of technical talent from the country to the West and the unfortunate adoption of an agitational approach by technologists in many parts of the country to better their service conditions, are but the external manifestations of a deep-rooted malady.

7.38. For any venture to be successful, the body of persons responsible for its operations should be contented and should be given adequate recognition for any significant and outstanding achievements for which they are responsible. They will then develop a sense of pride in the quality of work turned out by them, which will make for general improvement all round. This is extremely important where the huge task of developing the country's resources for the economic and social well-being of the people is concerned. In order that the schemes envisaged in Plans are completed economically, efficiently and speedily, the role of the technologist should be fully recognised and his service conditions not kept inferior to those of the general administrator.



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## SUMMARY OF RECOMMENDATIONS

1. Every Project should be examined and planned as completely as possible before its execution is begun to ensure that the user is not only provided with what is essential but completed phases of the project are made over to him in logical sequence. (2.2)
2. It is necessary to associate the agency for construction of a project from the earliest possible stage with the process of project formulation so that this agency may do the necessary pre-planning and advise the sponsoring authority suitably. (2.3)
3. Adequate surveys and data collection should be ensured with regard to construction materials, infra-structure, etc. to enable relative economies of alternative locations of projects to be worked out. (2.6 to 2.11)
4. There should be continuity in data collection and pre-planning. Data should be stored in a central place for future reference. (2.12)
5. Formation of a Central Hydrological Survey Department for collection of data in respect of water resources of the country on a continuous basis is considered necessary. (2.13)
6. Adequate time should be allowed for the planning effort between the project formulation stage and commencement of construction. (2.14)
7. For continuous investigation and data collection, suitably equipped permanent planning staff should be provided in every construction organisation. Large projects should be planned from the outset by the best available talent and professional expertise so that subsequent screening and criticism may not necessitate whole-sale changes in design and specifications. (2.15)
8. Projects should be developed in suitable phases. Modern programming techniques should be adopted to determine phasing. (2.16)
9. Optimum rate of financial input is an important factor and this should be ensured. (2.17)
10. Detail designs should be completed before construction is started. (3.2)
11. There should be a periodical review of design criteria and codes of practice so that these are updated incorporating modern developments in science and technology. Handbooks illustrating standard procedures of design in fields not already covered should also be brought out by I.S.I. (3.5)
12. Adoption of ultimate load theory in structural design should be aimed at. Necessary experimentation and testing programme should be undertaken. (3.6).
13. Methods of structural analysis and design practices using latest advances in science and technology should be attempted wherever possible with a view to reducing overall cost of construction. (3.7, 3.8)

14. In large-scale building projects, relative overall costs of multi-storeyed construction and dispensed low rise type construction should be studied in order to determine the most suitable and economical type. (3.9)

15. For large construction projects alternate designs should be prepared and relative economics studied before making a final decision. (3.11)

16. Temporary buildings are uneconomical and wasteful in the long run and should be resorted to only when requirement is for a very limited period and is transient in nature. (3.12).

17. There should be wider application of modern design and construction techniques in the practice of highway and air field engineering. (3.13, 3.14)

18. Standardisation of construction materials, codes of practice, etc. is being done by the I.S.I. These standards should be adopted by all construction departments and agencies. (3.15, 3.16)

19. All construction agencies should ensure modular coordination as envisaged in IS-1233-1958 while planning and designing structures. (3.17, 3.18)

20. A suitable design organisation should be set up in every State and for every large project. In addition there should be strong Central Design Organisations with accent on specialisation. Every design organisation should have, *inter alia*, a work study cell attached to it. (3.19, 3.20)

21. Design talent should be developed and groomed in all construction departments without jeopardising their career prospects. Continuity of design personnel should be ensured as that will make for development of expertise and specialisation. (3.21, 3.22, 3.23)

22. Design engineers should be given suitable opportunities to work in the field. They should be encouraged to visit construction sites where construction based on their designs is in progress. (3.24)

23. Competitive designing should be encouraged, prizes being awarded for best and economical designs. (3.25)

24. Indigenous consulting agencies could advantageously be made use of for designs in specialised fields. Consulting organisations have, therefore, to be built up, encouraged and nursed. (3.26)

25. Foreign consultants should be engaged, with the approval of highest technical authority in the field in which work is to be executed, only when essential expertise and experience are not available in the country. If employment of foreign consultants becomes unavoidable, they should preferably be engaged through Indian Consultants and be made responsible to them. (3.27)

26. Preparation of a National Building Code incorporating latest developments in the field of building design, construction techniques and materials has been taken up by the I.S.I. This Code should serve as a model for adoption by PWDs, local bodies and other construction agencies. (3.28 to 3.32)

27. Existing outdated building bye-laws of municipalities and corporations should be revised to fall in line with the Standard Code of Building Bye-laws prepared by the I.S.I. (3.33)

28. The N.B.O. should establish Development Groups to evolve norms, space and lay outs and help prepare economic designs for buildings of repetitive types. (3.34 to 3.37)

29. Industrialisation and mechanised methods of construction, suited to Indian conditions, should be gradually introduced in the interest of speed, quality control and reduction in cost. (3.38 to 3.44)

30. Requirements of construction plant and machinery should be periodically assessed and measures taken to produce indigenously those items which are not at present being so produced. (3.45 to 3.48)

31. For indigenous production, development of ancillary industries, interchangeability of parts and speed in training of operators, the various broad categories of equipment should be assessed so that a limited number of suitable makes and sizes are standardised. (3.49)

32. Procedures for provisioning of spare parts should be streamlined and the policy regarding their import simplified. (3.50 3.51)

33. Proper procedures should be laid down to ensure prompt and systematic maintenance and servicing of equipment. (3.52, 3.53)

34. To ensure maximum utilisation of common categories of equipment, Equipment Pools should be set up on a zonal basis to be run on commercial lines. (3.54)

35. For organising quality control, quality mindedness has to be inculcated in staff connected with a project. (3.56)

36. Laboratory methods of quality control should be adopted in lieu of the present methods of visual inspection and dimensional check. (3.57 to 3.63)

37. A Building Materials Assessment & Development Cell should be set up in every State with authority to encourage development of building materials industries and to recommend setting up of new production units in public sector in case private sector is unable to meet demand. The N.B.O. should act as a coordinating agency and should lay down methodology for the purpose. (4.3 to 4.7)

38. State should conduct surveys to locate and determine suitable deposits of soil for brick making and earmark sites for this purpose in Master Plans for urban localities. (4.8)

39. Productivity in the brick making industry should be increased by adopting improve methods of manufacture, increased adoption of mechanisation and semi-mechanisation and more efficient types of kilns. (4.9)

40. The present policy of issuing short-term licences to brick manufacturers deter them from investing capital and adopting modern techniques. Licensing and pricing policy of Government should be worked out on a long-term basis to permit continuity of manufacture. (4.10)

41. It will be advantageous to have price control on bricks and an equitable method for fixing fair prices linking these to prices of coal, labour, land rents and other inputs laid down. (4.11)

42. Credit facilities on reasonable terms should be made available to the brick and tile industry so that new entrepreneurs are encouraged to start new units and their products are available at competitive rates. (4.11).

43. Steps should be taken to collect regularly accurate and detailed statistics of output of construction timber and to assess trends of future production and demand. (4.13)

44. Efficient and modern methods of felling, logging, storage, conversion and transport of timber have to be adopted on a priority basis. Every Forest Department should have a qualified logging officer to train personnel. Improved logging tools should be made available by indigenous production. (4.14 to 4.16)

45. Methods of sale of timber trees to contractors by Forest Departments should be suitably modified to permit their sale in bigger lots and for longer periods to encourage mechanisation of operations. (4.17)

46. The remote and hitherto unexploited or partially exploited fir and spruce forests in the Himalayas, teak and sal forests in Dandakaranya and mixed forests in Western Ghats should be opened up to permit economic harvesting of available timber. (4.18)

47. To augment the supply of traditional species of construction timber, the large quantity of secondary species of timber available in the country should be made use of after being given suitable seasoning and preservative treatment. (4.19)

48. Secondary species of timber should be marketed in standard sizes and quality with certified markings after being properly seasoned and given preservative treatment. (4.20)

49. Specifications for construction timber stipulated by construction departments should be revised to permit use of secondary woods of reasonable quality. Standard cut sizes of timber specified in IS:1331-1958 should be adopted to the greatest possible extent. (4.21)

50. Nail jointed and laminated structures using small dimensioned and short length timbers should be adopted wherever feasible. (4.22)

51. Governments should encourage setting up of integrated saw-mill-cum-wood/workshops with facilities for sawing, seasoning, preservation and production of pre-fabricated components. (4.23)

52. Wider use of fibre boards and particle boards manufactured out of waste wood in lieu of timber boarding, should be encouraged. To bring down the selling price of particle boards, modification of the tax structure in respect of resins used in its manufacture is called for. (4.24).

53. Railways should restrict use of timber sleepers to those locations only where their use cannot be avoided. Generally, timber sleepers should be substituted by pre-stressed concrete sleepers. (4.25).

54. To encourage mechanisation of methods for quarrying stones & aggregates land leases should be given for a minimum period of, say, 10 years with possibilities of extension. Royalty and tax structures of the quarrying industry require study and rationalisation. (4.28,4.29).

55. As the stone aggregate industry is capital intensive, it needs assistance of institutional finance. (4.30).

56. Substitution of ordinary portland cement by cheaper cementing materials should be considered wherever possible. Increased adoption of weigh-batching and use of controlled concrete should be resorted to. Ready mixed concrete should be made available in areas of large construction activity. (4.33).

57. It is for consideration whether ordinary portland cement should not be marketed in more grades than one with a view to achieving more intensive utilisation. (4.34).

58. Improved methods should be evolved for packing cement so that loss in transit is minimised. (4.35).

59. Use of cement pozzolana mixes and lime reactive surkhi in lieu of ordinary portland cement should be resorted to wherever possible. Production and marketing of ready-to-use mixtures of lime pozzolana as a standard product should be encouraged. (4.36 to 4.39).

60. Formation of cooperatives of small producers of lime should be encouraged. Such cooperatives should have ancillary testing facilities for controlling quality and a marketing organisation. Lime industry should be included in the list of scheduled industries so that entrepreneurs may get requisite facilities. (4.41).

61. Measures should be taken to ensure production of light and junior series of Indian Standard Steel Sections. (4.43).

62. Use of cold formed light gauge sections and tubular sections should be considered wherever technically and economically feasible. Incentives by way of reduction in excise duties may be offered to lower the price of these products and thus encourage their use on a wider scale. (4.44).

63. Adoption of welded type steel structures should be encouraged. Production of weldable quality steel & electrodes should be increased. Production of high strength friction grip bolts should be increased and their use by design organisations encouraged. (4.45).

64. Modern design methods should be increasingly adopted for steel structures as such designs require lesser quantities of steel than conventional designs. (4.46).

65. Use of high strength deformed bars should be resorted to in lieu of plain-mild steel bars for reinforcement purposes. The integrated steel plants in the country should take up the manufacture of high strength deformed bars. National laboratories should develop the requisite indigenous know-how. (4.47).

66. Efforts should be made to use alternative materials in lieu of scarce traditional materials wherever feasible. (4.48).

67. Manufacture of light weight aggregates should be started in areas where stone is not readily available and has to be transported over long distances. (4.49).

68. To reduce import of asbestos fibre and zinc, asphaltic corrugated sheets and aluminised iron sheets should be produced indigenously. (4.50).

69. In regions where price of burnt clay bricks is higher than Rs. 70/- per 1000, manufacture and use of cellular concrete, using fly ash and lime, should be considered for adoption as walling materials. (4.51).

70. Wherever suitable clay for manufacturing bricks is not available, manufacture of sand lime bricks should be considered. (4.52).

71. Along with production of new construction materials suitable facilities should be created for training craftsmen in the proper use of these materials. (4.53).

72. Industrial cooperatives for producing construction materials should be encouraged by Central and State Governments by providing facilities in the form of financial assistance, marketing, laboratories for quality control, training of artisans, transport, etc. (4.54 to 4.56).

73. Modern methods of materials management should be resorted to in large projects. (4.57).

74. With a view to disseminating knowledge of improvements in designs and techniques and to displaying new materials, Building Centres should be set up at prominent locations in large cities and important towns. (4.58 to 4.60).

75. Contractors carrying out construction works for Government Departments and other public bodies should be given advance payments. These payments should be made out of normal budget allotment;

- (a) against supply of acceptable non-perishable materials brought to site and not incorporated in work;
- (b) in case of contracts valued at over Rs. 20 lakhs
  - (i) work advance against bank guarantee or fidelity bond of an insurance company;
  - (ii) against machinery (tools and plants) brought to site;
- (c) in case of contracts valued at over Rs. 10 lakhs, on execution of essential preliminary items of work such as, huttings for labour, site offices, etc., and against guarantees. (5.5).

76. Bank guarantees and fidelity bonds of insurance companies should be accepted towards earnest money security deposit/retention money. (5.6).

77. A Construction Finance Corporation with a capital of Rs. 100 million should be set up to advance funds on reasonable terms to contractors engaged on construction, to construction materials industries and to consulting engineer organisations. (5.7 to 5.14).

78. To develop healthy codes of conduct, improved technical competency and better general standards in the construction industry, a National Authority should prepare and maintain a National Register of Builders. (5.15 to 5.19).

79. Labour cooperatives should be encouraged and offered facilities to undertake construction works. (5.20).

80. It was considered necessary to evolve a Standard Contract Form for executing construction works so that general conditions are fair and equitable to both parties. This work has since been completed. Adoption of this form by all governmental construction agencies is recommended, with such minor modifications as may be necessitated by local requirements. (5.21,5.22).

81. Contracts should, as far as possible, be concluded on a lump sum basis. (5.23).

82. Specialised training in Quantity Surveying should be organised. (5.24).

83. Where the work is to be executed through the agency of contractors, selective tendering should normally be resorted to irrespective of whether the job is large or small. (5.25 to 5.27).

84. The system of Technical Examination by an external agency should be abolished and steps taken to intensify internal supervision and quality control. (5.28 to 5.35).

85. The existing system of settling disputes arising out of construction contracts by arbitration by an engineer/architect should continue. (5.36, 5.37).

86. Competent technical authorities should be empowered to settle disputes up to specified amounts without recourse to arbitration. (5.38).

87. The system of settling disputes by a single arbitrator should continue. The arbitrator should, however, be an Engineer/Architect acceptable to both parties. (5.39 to 5.41).

88. Procedure for implementation of arbitration awards should be streamlined. Chief Engineers should be authorised to decide whether or not an award should be implemented, after taking legal advice, where he considers such a course necessary. The practice of referring awards to Government or to some other department, before these are implemented, should cease. (5.42).

89. At the beginning of each financial year, lump sum allotments should be placed at the disposal of Chief Engineers for implementing arbitration awards, recoupment being made as and when required. (5.43).

90. An All India Standard Schedule of Rates priced on a zonal or other suitable basis should be prepared by the National Buildings Organisation and adopted by all departments carrying out construction works out of public funds. (5.44 to 5.49).

91. To enable technical heads of construction departments to discharge their responsibilities, adequate authority should be given to them by abolishing the present secretariat system of Public Works Ministries and replacing it by

a system based on an executive pattern so that both responsibility and authority vest in the head of the department and his senior technical colleagues. There is also a need for streamlining administrative procedures which are at present being followed by construction departments. (6.3 to 6.6).

92. The existing Ministry of Works should be suitably reorganised into a Central Ministry of Construction. Its role should be to arrange for economic and speedy execution of works financed by the Central Government to assist the construction industry as a whole in the wide range of problems which concern it, to encourage the development of new techniques and materials, to ensure proper utilisation of technical manpower and to build up expertise. (6.7.).

93. To coordinate the construction activities of different public sector undertakings, their construction should be carried out with the technical assistance of the proposed Construction Ministry without in any way interfering with the autonomy of these undertakings. (6.8.).

94. The proposed Ministry of Construction should aim at achieving economy in construction costs by proper management, satisfactory human relations, ensuring regular and coordinated supply of materials, etc. rather than by merely lowering scales of accommodation and specifications. (6.9.).

95. Construction staff of Public Sector Undertakings should be borne on a regular cadre operated by the Central Ministry of Construction so that individuals are assured continuity of service and surplus technical staff is not discharged on completion of works but is transferred from one undertaking to another or elsewhere, as necessary, and the experience gained is properly utilised. (6.10.).

96. The Central Ministry of Construction should be so organised that there is maximum centralisation of policy making and maximum decentralisation of executive authority. (6.11.).

97. The procedure for liaison between the proposed Ministry of Construction on the one hand and the Council of Scientific and Industrial Research and the National Laboratories on the other should be laid down so that results of research in construction techniques are utilised and the problems encountered in the field are fed back to the laboratories for further research and study. (6.12, 6.13).

98. The Construction Ministry should be so constituted as to carry out all Central Government works except those pertaining to the Ministries of Defence, Railways and Irrigation & Power. (6.14, 6.15).

99. In a State if in any branch of engineering the number of Chief Engineers is more than one the seniormost/selected Chief Engineer should function as a Principal Secretary and other Chief Engineers as Secretaries. All Chief Engineers of the branch should act as a Board for formulation of policies for the branch and for taking decisions on technical schemes above a specified limit. (6.16).

100. To draw up integrated plan of development including judicious allotment of priorities and to review all problems of technical nature, each State should set up an Advisory Board of Engineers, architects and other technologists. The Chairman of the Board will be responsible for tendering advice to the State Cabinet on technical matters. (6.17 to 6.19).

101. Existing rules and procedures for accounting in Public Works Departments should be modified with a view to eliminating interference, delays, etc. so that it is easier for a project authority or head of an organisation to work efficiently. (6.21).

102. Accounting should be separated from Audit and made the responsibility of Chief Engineers. To enable a Chief Engineer to exercise this responsibility a Controller of Accounts with suitable staff should be placed under him. (6.23 to 6.25).

103. All payments should be made by executive engineer after technical, arithmetical and primary audit checks have been exercised in his office. Pre-payment audit by an external agency should be done away with. External audit parties should carry out post payment audit. (6.28).

104. The system of Cost Accounting should be introduced in Public Works Departments and in large projects and Cost Accounting Cells set up for the purpose. (6.29).

105. For maintaining an optimum programme of construction on important projects, funds should be allocated over a long period and not by annual budgetary provision. (6.30).

106. The National Buildings Organisation should be reorganised as an autonomous body to enable it to carry out not only the existing tasks but also the additional functions which have been outlined for it. (6.31 to 6.37).

107. Terms and conditions of service of engineering personnel, architects and other technologists need to be reviewed. Control of technical departments from the lowest level to the highest should be in technical hands both in the States and at the Centre. (7.3).

108. The present system which permits assessment of capabilities of technical personnel by officers of the administrative cadre should be abolished. Performance of technical personnel should be judged by their superior technical officers only. (7.4).

109. The existing disparity between salary and status of engineers, architects and other technologists in Class I service on the one hand and of officers of the Indian Administrative Service on the other should be removed and pay and status of the former should not be lower than of those in the Administrative Service for equivalent length of service. Formation of the Indian Service of Engineers should be expedited. (7.5).

110. A technologist who during his employment acquires additional qualifications or makes an outstanding contribution should be appropriately rewarded. Whenever an engineer or a team of co-workers show higher efficiency, they should be suitably rewarded. (7.6).

111. National awards should be instituted in the field of technology and construction economy. (7.7).

112. Extreme degree of vigilance exercised by the Special Police Establishment, Vigilance Departments and other similar agencies, though useful to some extent, acts as a disincentive to serious and sincere workers even

at senior levels resulting in loss of initiative. A review of these measures is considered essential. (7.8).

113. Technical officers of construction services should be given training soon after recruitment, in matters of works procedure, accounts procedure, personnel administration and other administrative and departmental procedures before they are placed incharge of sub-divisions. (7.11 to 7.13).

114. Technologists serving in construction departments should be put through 'in-service' training courses periodically. These courses should be in the form of refresher courses, advanced courses and specialised courses which would enable them to keep abreast of rapidly developing technology in the field of construction and to acquire post-graduate qualifications. (7.14, 7.15).

115. Civil engineers should be given special training in quantity surveying. (7.16).

116. Subordinate supervisory staff should be put through training courses and refresher courses which should lay stress on practical aspects of construction, methods of conducting tests and precautions to obtain good workmanship. (7.17).

117. The Department of Labour & Employment should review the list of trades for which training is imparted in the I.T.Is. Training in building construction trades should be diversified. (7.19 to 7.21).

118. Capacity for training of welders should be increased. (7.22).

119. Forest departments should arrange training in the use of modern logging tools and in equipment for extracting & fashioning of timber. (7.24).

120. In-service training in modern timber engineering techniques should be given to personnel employed on supervision of building construction. (7.25).

121. Ministry of Labour & Employment should set up training centres to impart training in the operation of construction machinery and in carrying out servicing and repairs to such equipment. (7.26).

122. To overcome the shortage of hereditary master-craftsmen in the country suitable training facilities should be provided so that intelligent craftsmen with potential qualities of leadership could be selected and trained for the purpose. (7.27).

123. Training of craftsmen should be provided for in every large project by absorbing expenditure on training in the project outlay. Public Works Departments should also devote attention to training of craftsmen. (7.29, 7.30).

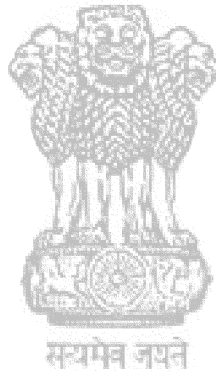
124. Workers who are already skilled should be given facilities for obtaining trade certificates without having to undergo a formal course of training. The responsibility for recognising competence of an institution to issue certificates should be vested in a Central Body such as the Labour Ministry. (7.31).

125. The construction industry should take interest in the training of apprentices in construction trades in accordance with the Apprentices Act 1961. (7.32).

126. Dissemination of technical information and data having a bearing on construction economies achieved in the country in the past is necessary so that engineers, architects and others engaged on construction projects may profit from experience of others. (7.33).

127. The NBO, IRC, CW&PC, CBI&P, ISI and other similar organisations should extend their facilities to serve as clearing houses for dissemination of technical information in their respective fields. All engineering project organisations should publish detailed reports on all matters connected with the achievement of efficiency and economy obtained through their construction operations. A specific provision therefor should be made in the project and the responsibility for writing such reports placed squarely on the chief executive. (7.34).

128. An independent journal on "Engineering Construction Economy" should be started. It should be produced attractively and made available to all concerned at a reasonable price. (7.35).



## APPENDIX-A

### IMPORTANT RECOMMENDATIONS SUBMITTED TO THE MINISTER OF WORKS, HOUSING AND URBAN DEVELOPMENT (See para 0.12)

1. Substantial parts of the Plan will not be fulfilled if the necessary factories, buildings, roads etc. are not constructed in the first three or four years. So far it has been assumed that the processes which every project has to undergo before work begins can be speeded up and that the Construction Industry and the Building Materials Industries will expand automatically to meet the greatly increased load now proposed. Neither of these assumptions is justified.

2. Various Committees have put forward recommendations for improving existing rules and regulations but the approach of all concerned has been governed by the importance attached to ensuring that no Government servant is in a position to take any action which might be detrimental to what Government's financial interests may be and the conviction that the contractor's interests are generally at variance with Government's, and that it is no part of Government's business to make it easier for him to meet conditions of his contract.

3. The first approach has resulted in regulations which tend to water down authority of the officer charged with ensuring satisfactory completion of the project and require him to justify almost every decision he makes to administration, finance, audit, security and technical examination.

The second results in one-sided contract conditions unnecessary delays in conveying decisions, harassment by supervisory and other staff and delays in settlement of bills.

4. The amendment of this or that regulation, or recommendations of a general nature about design, specifications or contracts will achieve little appreciable improvement. It is urged that our approach should now be more dynamic and that rules and regulations should be framed with a view to speeding up the process of arriving at decisions.

5. In the ensuing paragraphs are listed the recommendations which we are convinced will markedly increase efficiency. We do not believe, however, that they can be satisfactorily implemented unless the Ministry primarily charged with the responsibility for Public Construction arms itself and all its personnel with ample authority to discharge its responsibility speedily, confidently and efficiently.

### PREPLANNING

6. The greatest scope for economy in construction is at the pre-planning stage. Every project should be planned as completely as possible before its execution is begun, so that essential requirements are overlooked, and physical targets are achieved phase by phase.

7. To achieve the above aims, the following recommendations are made :

- (a) Detailed physical Plans should be prepared for every Five Year Plan, as without these implementation of Plans is very doubtful ;
- (b) Continuity in planning and data collecting programme ; adequate investigation of projects ; sufficient time for preparing ; adequate staff and funds for pre-planning ; adequate time for detailed planning (preparation of drawings, bills of quantities, list of materials required, general management, etc.) ;
- (c) Phasing of projects so that benefits accrue from the earliest possible stage ;
- (d) Large projects should be planned from the outset by the best available talent and professional expertise so that subsequent screening and criticism may not necessitate wholesale changes in designs and specifications.

## DESIGNS AND OTHER TECHNOLOGICAL FACTORS

### *Design*

8. Preparation of designs in detail well before embarking on construction is vital in order to ensure orderly construction and speedy completion. A good specification should have clarity besides being detailed. As Government and semi-Government organisations cannot possibly cope with the volume of work expected during the Fourth Plan, it is necessary that consultancy practices be built up in the country, more especially for works of a special nature. The existing P.W.D. and municipal building codes and bye-laws are outdated and need to be modified to bring in more economy in construction.

9. The steps indicated below are recommended for adoption :

- (a) Preparation by ISI of upto-date design criteria and their periodical review (review every 5 years); assessment of loads and safety factors in the design of structures to be reviewed;
- (b) Greater collaboration and communication of results between various engineering organisations and research institutions; task to be carried out by NBO and IRC;
- (c) Planning to be on a modular basis to promote progressive standardisation at national level of construction components; some of the examples are doors and windows, electrical fittings, ceiling tiles, small bridge spans, etc.;
- (d) Every construction department of the Center and of the States and every project authority to have a design cell and an architectural wing; in addition, a strong Central Design Organisation with accent on specialisation; steps to attract best brains to all design organisations and to retain continuity in design personnel;
- (e) Consultancy practices to be built up, encouraged and nursed with different units specialising in different disciplines of engineering; employment of foreign consultants only with approval of highest technical authority in the field; foreign consultants to be engaged only when the essential expertise and experience are not available in the country and then if possible on a partnership basis with Indian consultants;
- (f) To ensure consideration of various alternatives in technological design and construction and to permit use of variety of materials and new techniques, particularly in buildings of repetitive nature, bridges and other special structures, contractors should be encouraged to submit alternative tenders based on their own design;
- (g) A model National Buildings Code for the country as a whole to be prepared by ISI and periodically reviewed with a view to keeping it upto-date; this code to replace existing PWD and municipal codes;
- (h) A review of building bye-laws of Corporations, Municipalities, etc., based on model bye-laws to be prepared by ISI;
- (i) Application of industrialised practices to traditional construction and gradual introduction of industrialised pre-fabrications suited to Indian conditions;
- (j) NBO to establish Development Groups for works of repetitive nature e.g. housing, schools, hospitals, offices, etc.;
- (k) Temporary buildings are uneconomical and wasteful in the long run and should be resorted to only when requirement is for a very limited period.

### *Mechanisation*

10. Introduction of such mechanisation in construction processes as is necessary to achieve quality, speed and economy.

11. Construction equipment consists broadly of two types viz. mobile plant and stationary plant. To achieve sufficiency in their production and to reduce idle time which may be due to exclusive ownership, poor maintenance, or restrictions on release of foreign exchange for spares, the following recommendations are made.

- (a) High priority to be accorded to indigenous production of construction machinery and plant which, in respect of certain types of equipment, is already in hand;
- (b) Standardisation of construction equipment and categories (A committee to deal with this subject has already been set up by ISI);
- (c) Modern methods of maintenance of equipment, streamlining of procedures for ordering spares, etc., and setting up adequate spare facilities;
- (d) Setting up of equipment pools on commercial lines and on zonal basis, each zone being equipped with its own operational staff and repair facilities.

#### *Quality control*

12. Quality control is essential in construction projects of any magnitude; to be effective it must be systematic and continuous. Quality mindedness should be inculcated in staff connected with a project.

13. Following recommendations are made :

- (a) Field laboratories at all major construction sites; a large organisation to have a central laboratory assisted by field laboratories; specialised laboratory equipment and adequately trained staff for carrying out checks;
- (b) Internal departmental check to be systematic and responsible; technical examination by an external agency cuts across the function of the responsible engineer and undermines the authority of the responsible head of a department.

### CONSTRUCTION MATERIALS

14. Materials constitute two-thirds of the cost of any construction work. Serious shortages are likely to be faced in the Fourth Plan period in respect of building materials like Bricks & Tiles, Timber, Lime, Quarried materials, Cement and Steel unless appropriate steps are taken to overcome these shortages.

15. The under-mentioned recommendations are made :

- (a) A Building Materials Assessment & Development Cell to be set up in every State ; NBO to act as a coordinating agency and to lay down methodology for the purpose ;
- (b) *Bricks/Tiles* : Intensification of research and introduction of greater mechanisation in the field of manufacture of bricks and tiles; rationalisation of manufacture of bricks and tiles; rationalisation of licensing policy to permit continuity of manufacture ;
- (c) *Timber* : Adopting improved practices for felling, logging, transport and conversion; more intensive use of secondary species after proper seasoning and treatment; improving market availability of timber in standardised size and quality; encouraging increasing use of fibre boards and particle boards in place of solid wood and adoption prestressed concrete sleepers in lieu of wood sleepers;
- (d) *Cement and lime* : Economy in cement through greater use of prestressed concrete, specifying concrete by strength, producing ready mixed concrete, making use of cement pozzolana mixes instead of pure cement; making use of alternative building mortars, such as, lime pozzolana, lime reactive surkhi; use of cement fly-ash mix for concrete;

Marketing of cement in different grades to achieve optimum utilisation; encouraging production of good quality lime and factory-produced lime pozzolana mixes;

- (e) *Quarried materials* : Rationalisation of licensing policy to permit continuity of production; modernisation and greater mechanisation in the field of quarried production, handling and conveyance; greater use of light-weight and clay aggregates;
- (f) *Steel* : Greater use of high-tensile steel and medium tensile deformed bars; greater use of light-weight Indian Standard Sections, cold-formed sections and tubular sections; greater production of welding quality steel to permit welding on a large scale; to prevent over-designing tested steel should be freely available;
- (g) *New Materials* : In order to encourage development of new materials, such as, light-weight and clay aggregates, cindered fly-ash aggregates, cellular concrete blocks, asphaltic roofing sheets, etc., a Building Materials Development Corporation should be set up ;
- (h) *Building Materials Display Centres and Information Services* to be set up in large towns;
- (i) *Materials management techniques*, particularly of inventory control and value analysis, to be widely adopted.

### THE BUSINESS OF CONSTRUCTING

16. Production of a building or a structure is the result of the efforts of engineers and architects on the one hand and contractors and building materials industry on the other. These parties have to work as a team in a joint effort. Lack of appreciation of this factor has led to certain unsatisfactory features in contract conditions and in the working of contracts. Most of Government contracts throw a disproportionate share of the burden of unforeseen expenditure and risks on contractors and, in consequence, tenders tend to be high.

The quantum of construction in the First and Second Five year Plans was below the available capacity of construction industry and accordingly no action was felt necessary to take any active measures to expand or improve this industry. Therefore, it appears that in the Third Five Year Plan, it was assumed that the construction industry would continue to expand automatically to cope with whatever load was thrown on it. In the middle of Third Plan, however, the industry was severely strained to meet the increasing demand.

In the Fourth Plan, the construction work is so large that unless definite measures are taken to expand, improve and encourage this industry, the targets will not be achieved.

17. The following measures are, therefore, suggested :

#### *Input of finance*

- (a) At present, builders obtain finance mostly from private parties at exorbitant rates of interests, borrowings from banks or *ad-hoc* advance payments from clients are extremely limited. In order to modernise construction industry to speed up construction, to obtain greater competition, to draw-in more qualified technical persons towards building industry and to lower construction costs due to keener competition, it is suggested that short-term and long-term measures be adopted to afford financial help to the construction industry.

Short-term measures to consist of the grant of the following advance payments out of normal budget allotment :

- (i) Against supply of non-perishable materials;
- (ii) Against bank guarantee or against fidelity bond of an insurance company, in case of projects valued at over Rs. 20 lakhs;
- (iii) Against machinery (T&P) brought to site;
- (iv) On execution of essential preliminary items of work, such as, huttings for labour, site offices, etc. and against guarantees, in case of projects valued at over Rs. 10 lakhs;

Long-term measure to consist of setting up of an independent Finance Corporation to advance finance for the development and expansion of the construction industry generally and in particular to advance funds too :

- (i) Building firms and contractors;
- [(ii) Consulting Engineer Organisations;
- (iii) Building Materials Industry.

#### *Registration of contractors*

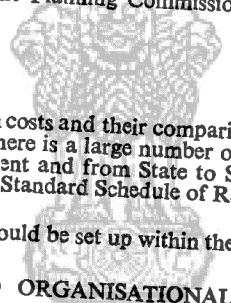
- (b) For modern construction techniques contracting for construction work must be recognised as a specialised industry. In order to ensure that the business of contracting is properly organised, it is necessary to have large (for contracts above Rs. 20 lakhs) building firms and contractors on a National Register. A suitable organisation should be set up to prepare and maintain this register ;

#### *Contract forms*

- (c) Standard contract forms in use in Government departments throw on contractors undue share of risk for unforeseen conditions; terms of payment and settlement of disputes are inequitable; capital gets unduly locked up in the form of earnest money and security deposit/retention money.

Standard Contract Forms need urgent revision . An expert committee should be set up by the Planning Commission to prepare revised Standard Contract Forms;

#### *Schedule of Rates*

- (d) Analysis of construction costs and their comparison are dependent on schedule of rates. At present, there is a large number of these schedules varying from department to department and from State to State. There is a requirement to prepare an All India Standard Schedule of Rates priced on zonal basis. 

A suitable cell should be set up within the NBO to undertake this task.

### ADMINISTRATIVE AND ORGANISATIONAL FACTORS

18. In order to achieve economy, efficiency, and speed in construction works, it is essential that the present system of public works administration be modified. The Building Projects Team of the Committee on Plan Projects has made a study of this subject. The present system provides for unnecessary checks and restraints which lead to lack of faith and confidence and to a marked tendency to avoid taking decisions. It does not permit of bold actions and trials of new ideas and scientific advances. Planning and research involve risks and also expenditure which may not always produce direct results. The present system of budgeting and accounting leads to avoidable delays.

19. The following recommendations are made :

- (a) In order to ensure that adequate authority is given to Heads of Construction Departments to discharge their responsibilities, the present system of secretariat control be abolished in favour of a system on the lines of the Railway Board pattern so that both responsibility and authority may vest in the Head of the technical department and his senior technical colleagues;
- (b) At present, there is no machinery in the States for pooling technical data and experiences with a view to drawing up an integrated plan of development which will include judicious allotment of priorities, assembly of resources with reference to needs of a project, draw up realistic programme of execution, etc.;

It is, therefore, necessary to set up a highpowered body of technical experts i.e. a Board of Engineers and Architects for each State charged specifically with the responsibility of coordinating all engineering activities and tendering expert advice on important technical and other allied matters affecting development of the States;

The Chairman of the Board will be the Chief Technical Adviser to Govt. and will have necessary technical staff to assist him. The staff organisation will consist broadly of Directors of planning and coordination, of personnel and administration, of construction equipment (with a suitable set-up on zonal basis to look after mechanical equipment), of construction materials, of work study and research and development and information;

- (c) Considerable rationalisation of accounting procedures for public works with a view to eliminating interference, delays, outdated rules, etc., and making it easier for a project authority or head of an organisation to work efficiently, this will also mean economy in overhead charges;
- (d) Separation of audit from accounting;
- (e) Cost Accounting Cells be created in each department and on all major projects;
- (f) In order to prevent waste, sufficiency of funds during construction to conform to phases of completion as visualised at the time of sanctioning of projects to be assured: budget procedures to be modified accordingly;
- (g) NBO to be expanded to cater for Building Materials Assessment and Development Group, Development Groups for repetitive types of work, preparation of Standard Schedule of Rates and greater dissemination of technical information ;
- (h) There is yet some room for economy in scales and specifications of buildings etc. now being constructed from public funds. Far too many public authorities and autonomous bodies are executing projects by their own agencies and to their own scales and specifications. It is essential that over-riding authority in this field be exercised by a Construction of Public Works Ministry organised to ensure that all buildings etc. financed from public funds conform to accepted and economical standards. This Ministry should be responsible for carrying out all construction works financed by the Central Govt. including works for public sector enterprises and for autonomous organisations except works for Defence, Railways and Irrigation & Power.

## MOTIVATION, TRAINING AND PUBLICITY

### *Motivation*

20. Motivation and incentives are largely concerned with psychological and human factors which have to be taken into account to get the best out of technical personnel engaged in construction projects. Incentives present an appropriate device through which motivation may be provided but they cannot by themselves meet the present-day challenge where many complex human problems are involved. ■

21. The following recommendations are made :

- (a) Terms and conditions of service of engineering personnel and architects in public works departments need to be reviewed; pay and status of engineers and architects in class I service should not be lower than those of any other All India Service for equivalent length of service; formation of "Indian Service of Engineers" to be speeded up;
- (b) A technologist who during his employment acquires additional qualifications or makes an outstanding contribution towards achieving economy should be appropriately rewarded; such rewards may take the form of advance increment, accelerated promotion; etc.; departmental Head to be the competent authority to recognise and reward good achievement;

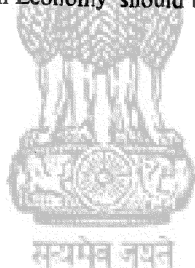
- (e) National level awards to be introduced in the fields of technology and economy of construction ;
- (d) Extreme degree of vigilance exercised in recent years by SPE, CTE, Vigilance Departments and other similar agencies, though useful to some extent, acts as a disincentive to serious workers resulting in loss of initiative even at senior levels; review of these measures is considered essential.

### *Training*

- 22. To enable engineers and architects to keep abreast of rapidly developing technology in the field of construction, engineers and architects in Government employment should be encouraged to attend refresher course, advanced courses, specialised courses, etc., and to acquire post-graduate qualifications.
- 23. Training facilities for construction tradesmen should be expanded.
- 24. A system of certification of skilled tradesmen should be introduced.
- 25. The category of master craftsmen should be built up.

### *Publicity*

- 26. Wide publicity is essential for promoting achievement of significant economies. It is necessary to bring to the attention of engineers important technical information and data having a bearing on construction economy, of which a large volume is already available in the country as a result of past researches and actual construction experience.
- 27. The NBO, ISI, CW&PC, Central Board of Irrigation & Power, the Indian Roads Congress and other similar organisations should extend their facilities to serve as clearing houses for technical information in their respective fields. All large engineering projects should publish detailed reports on all matters connected with the achievement of efficiency and economy obtained during construction operations. An independent journal on 'Engineering Construction Economy' should be started.



# APPENDIX-B

## STRENGTH CHARACTERISTICS AND OTHER PROPERTIES OF COMMON COMMERCIAL TIMBERS IN INDIA (See para 4.19)

S. No.	Species	Trade name	Uses	Natural durability	Treat-ability	Refrac-toriness to air season-ing	Strength classifi-cation	Zonal classification and availability
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	<i>Abies pln-drow</i>	fir	ABCDE	III	D	C		NX
2.	<i>Acacia ara-bica</i>	Babul	AB	III	b	B	ST	NXEYCX]
3.	<i>Acacia ca-tachu</i>	cutch	—	I	—	A	SP	NOEX CXWYSZ
4.	<i>Acer spp</i>	maple	—	III	—	B	—	NYEZ
5.	<i>Acrocarpus fraxinifolius</i>	mundani	C	III	c	B	ST	EZSZ ]
6.	<i>Adina cordi-folia</i>	haldu	BCE ]	III	a	B	O	NXEXCX WYSX
7.	<i>Albizzia or-doratissima</i>	Kala siris	ABCDE	I	e	B	SP	NYEYCZ WZ
8.	<i>Albizzia procera</i>	safed siris	ABCDE	II	c	B	O	NYEYOZ WZSZ
9.	<i>Albizzia stipulata</i>	siris	—	III	e	B	—	EZSZ ]
10.	<i>Albizzie ] lebeek</i>	Kokko	ABCDE	I	e	B	St	NYEYCZ WZSY
11.	<i>Alstonia scholaris</i>	Chaitian	—	III	—	c	—	NZEZWZ SY
12.	<i>Altingia ex-celsa</i>	jutili	—	II	c	A	ST	EZ
13.	<i>Amoora wallichii</i>	Amari	—	II	—	B	St	EY
14.	<i>Anogeissus latifolia</i>	axlewood	ABD	III	e	A	ST	EY
15.	<i>Anthocephalus cadamba</i>	kadam	—	III	a	C	O	EXSZ
16.	<i>Artocarpus chaplasha</i>	chaplash	ABCDE	II	d	B	O	EX
17.	<i>Artocarpus hirsute</i>	Aini	BCE	III	—	B	St	WYSY
18.	<i>Artocarpus heterophyllus</i>	Kathal	AB	I	—	B	—	NZEYCZ
19.	<i>Artocarpus lakoocha</i>	lakooch	—	I	—	B	O	EZSZ

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
20.	<i>Bassia latifolia</i>	muhua	—	I	e	A	O	NZEXCX
21.	<i>Bischofia javanica</i>	uriam	—	III	e	A	—	EYWYSZ
22.	<i>Borassus flabellifer</i>	palmyra palm	—	III	b	—	—	—
23.	<i>Boswellia serrate</i>	salai	ABD	III	e	C	O	—
24.	<i>Bridelia retusa</i>	kasi	ABD	II	e	B	O	BYEXSZ
25.	<i>Brugmiera spp</i>	bruguiera	—	III	a	—	—	—
26.	<i>Bucklandia populnea</i>	pipli	—	—	—	C	—	EZ
27.	<i>Calophyllum spp</i>	poon	ABCE	II	e	B	O	WZSY
28.	<i>Canarium strictum</i>	white dhup	—	III	—	C	ST	WZSY
29.	<i>Castanopsis hystrix</i>	Indian chestnut	—	III	b	B	O	—
30.	<i>Cassia fistula</i>	rajbrikh	ABD	II	—	A	—	NYEX CZWZ
31.	<i>Casuarina equisetifolia</i>	Casuarina	ABD	III	c	A	ST	EYWYSZ
32.	<i>Cedrela toona</i>	toon	CE	III	c	B	O	NXEY
33.	<i>Cedrus deodara</i>	deodar	ABCDE	I	e	C	O	NX
34.	<i>Chloroxylon tabularis</i>	satinwood	ABDE	III	—	A	ST	EZCX WZSY
35.	<i>Chukrassia tabularis</i>	chikrassy	ABCDE	III	c	B	O	EZWZ SZ
36.	<i>Cullenia excelsa</i>	Karani	BC	III	b	C	ST	—
37.	<i>Cupressus torulosa</i>	cypress	—	I	e	C	O	NY
38.	<i>Cynometra polyandra</i>	ping	ABD	III	b	A	SP	EZ
39.	<i>Dalbergie latifolia</i>	rosewood	BE	I	—	B	O	EZCYSX
40.	<i>Dalbergia sisoo</i>	sissoo	BE	II	e	B	O	NXEY
41.	<i>Dischopsis elliptica</i>	pali	—	II	e	B	ST	SX
42.	<i>Dillenia spp.</i>	dillenia	ABCDE	III	—	B	O	WY
43.	<i>Diosyros melanoxylon</i>	ebony	ABD	III	—	B	O	NZEZ CXWX SY
44.	<i>Dipterocarpus macrocarpus</i>	hollong	ABCD	III	a	b	SP	EX
45.	<i>Dipterocarpus spp.</i>	gurjan	ABCD	III	b	B	ST	EX.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
46. Duabanga	limpati	—	—	III	c	C	O	EX.
47. Dysoxylum malabaricum	white ce- dar	CE	—	I	—	B	ST	WZSY
48. Eugenia spp.	Jaman	—	—	II	e	A	ST	ZYCY WYCY
49. Garuga pinnata	garuga	—	—	III	e	B	O	NZEY WXSZ.
50. Gmelina ar- borea	gamari	CE	—	I	—	B	O	EYCYWZ SY
51. Grevillea robusta	silver oak	—	—	—	—	B	—	NZSY
52. Grewia tilliaefolia	dhaman	—	—	II	d	B	—	NYCZSY
53. Hardwickia binata	anjan	—	—	I	e	A	O	CYWZSY
54. Hardwickia pinnata	piney	ABD	—	I	e	B	ST	SY.
55. Heritiera minor	sundri	—	—	III	—	A	—	—
56. Holoptelea integnifolia	kanju	E	—	III	b	B	O	NXEYCS SZ.
57. Hopea spp.	hopea	ABD	—	I	e	A	—	SY.
58. Hymenodic- tyon excelsum	kuthan	CE	—	III	e	C	—	NZEZ CZWZ
59. Juglans regia	walnut	E	—	III	—	B	O	SZ
60. Lagerstroemia flos-reginae	jarul	—	—	II	e	B	O	NY WZ SZ.
61. Legerscroemia lanceolata	benteak	ABCDE	—	I	e	B	ST	WXSX
62. Lagerstroemia hypoleuca	pyinma	ABCD	—	II	—	B	O	EX.
63. Lagerstroemia parviflora	lendi	ABD	—	III	e	—	ST	NZ EX CX SY
64. Lophopetolum wightianum	banati	—	—	III	a	C	O	WZ SZ
65. Mangifera indica	mango	—	—	III	a	C	—	NX EX CYWZS
66. Melia sp.	—	—	—	—	—	B	—	NX EX CYWZ S.
67. Mesua ferrea	mesua	ABD	—	I	e	B	O	EX.
68. Michelia spp.	champ	—	—	III	e	B	O	EX.
69. Mimusops littoralis	bullet wood	BCE	—	I	e	A	—	—
70. Mitragyna parvifolia	kaim	BCE	—	III	b	B	O	NY EY CX WY SY.
71. Ougenia dalvergioides	sandan	ABD	—	I	—	B	O	NY CY CY WZ.
72. Pheobe spp.	bonsum	—	—	III	c	B	O	EZ
73. Picea mori- nda	spruce	ABCDE	—	III	d	C	O	NX.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
74.	<i>Pinus excelsa</i>	blue pine	ABCDE	III	c	C	O	NX
75.	<i>Pinus longifolia</i> ..	chir	ABCDE	III	b	C	O	NX
76.	<i>Planchonia andamanica</i>	bailada	—	—	—	—	ST	—
77.	<i>Pecilonuron indicum</i>	balagi	A	II	e	A	SP	SY.
78.	<i>Polyathia</i> spp.	debdaru	—	III	—	B	—	EZ WZSZ
79.	<i>Pterocarpus dalbergioides</i>	padauk	ABCDE	I	e	B	ST	EX
80.	<i>Pterocarpus karsupium</i>	bijasal	ABE	I	e	B	ST	EX CX WY SY.
81.	<i>Salmalia malabarica</i>	semul	—	III	a	C	—	NX EX CX WY SY
82.	<i>Schima wallichii</i>	chilauni	ABCD	III	d	B	—	EX
83.	<i>Schleichera trijuga</i>	kusum	A	III	a	A	SP	NZ EY CX WZ
84.	<i>Shorea assamica</i>	makai	ABC	III	c	B	O	SY.
85.	<i>Shorea robusta</i>	sal	ABD	I	e	A	ST	NX EX CX
86.	<i>Stereospermum</i> sp.	padri	—	III	—	B	O	EZ CY WZ SY.
87.	<i>Tamarindus</i>	imli	A.	—	—	B	—	EZ CZ SX.
88.	<i>Tectona grandis</i>	teak	ABCDE	I	e	B	O	EY CX WX SX.
89.	<i>Terminalia arjuna</i>	arjun	ABD	II	b	B	O	NZ EX. CS SX
90.	<i>Terminalia bialata</i>	White chuglam	ABCDE	III	e	B	ST	EX.
91.	<i>Terminalia .. belerica .. bialata</i>	bahera	ABD	III	b	B	ST	NX EX CX WY SX
92.	<i>Terminalia chebula</i>	myrabolan	ABD	II	b	B	O	NZ EX CS SY.
93.	<i>Terminalia black/changlam</i>	black/changlam	ABCDE	III	c	A	ST	NYSY
94.	<i>Terminalia .. myriocarpa</i>	hollock	ABCDE	III	a	B	ST	EX.
95.	<i>Terminalia peniculate</i>	kindal	ABD	II	c	A	ST	WYSX.
96.	<i>Terminalia Procera</i>	White/bombwe	ABCDE	III	b	B	O	EX.
97.	<i>Terminalia tomentosa</i>	laurel	ABD	II	b	A	ST	NX EX CX WX SX.
98.	<i>Tetrameles nudiflora</i>	maina	—	III	a	C	—	EX WZ SX
99.	<i>Vateria indica</i>	vellapiney	—	III	e	C	O	WZ SX.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
100.	Vitex altissima	milla	—	I	—	A	SP	SZ.
101.	Xylia xylocarpa	irul	AD	I	O	A	—	EY WY SX.
102.	Zanthoxylum rhetsa	mullilam	BCE	II	—	B	—	WZ SZ.

NOTES:—Col. 4—Recommended uses after suitable treatment, as substitutes for teak and sal.

A—Beams, rafters, purlins, trusses  
 B—Chowkats  
 C—Door and window leaves and ceilings  
 D—Struts and columns  
 E—Furniture

Col. 5—Natural durability

I—Timbers having an average life of 120 months & over  
 II—Timbers having an average life of 60 to 119 months  
 III—Timbers having an average life of 59 months and below.

Col. 6—Treatability :—

a—Heartwood easily treatable  
 b—Heartwood treatable but complete penetration of preservative not always obtained  
 c—Heartwood only partially treatable  
 d—Heartwood refractory to treatment  
 e—Heartwood very refractory to treatment, penetration 2 being practically nil from side end

Col. 7—Refractoriness to air-seasoning—

A—Highly refractory  
 B—Moderately refractory  
 C—Least refractory

Col. 8—Strength classification (as per I.S. 883)

SP—Super  
 ST—Standard  
 O—Ordinary

Col. 9—Zonal classification and availability:

(a) Zone (Classification as per IS. 399)

N—North Zone  
 E—East Zone  
 C—Central Zone  
 W—West Zone.  
 S—South Zone.

(b) Availability (as per IS; 399)

X—Most common (1,000 tonnes or more per year)  
 Y—Common (250 tonnes per year)  
 Z—Less common (less than 250 tonnes per year)

(1) primary species  
 (2) secondary species with treatability

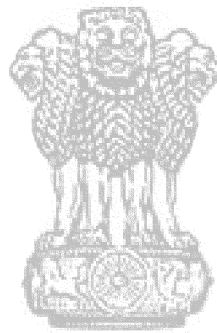
Recommendations—

For permanent structures—First choice:—

a & b and refractoriness C & B.

Second choice:—secondary species with treatability c & d and refractoriness B & A

For temporary structures—Secondary species with treatability d & e and refractoriness A & B.

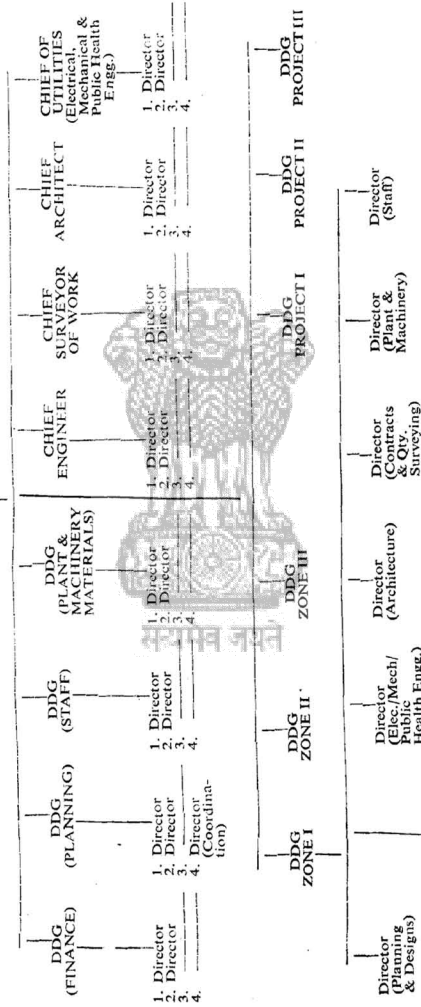


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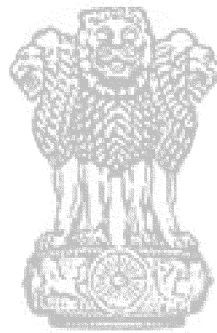
APPENDIX-C  
PROPOSED ORGANISATIONAL SET UP OF CENTRAL MINISTRY OF CONSTRUCTION  
(See para 6.15)

DIRECTOR GENERAL OF CONSTRUCTION  
(DGC)

ADDITIONAL DGC  
(Addl. DGC)



NOTE : 1. All DDG & Chiefs will be of the same status.  
2. All Directors will be of the same status.  
3. Number of Directors under DDG in DGC's office will depend upon work load.



सत्यमेव जयते

*Explanatory notes*

1. The Director General of Construction (DGC) will be responsible for planning, design and execution of all works services pertaining to all Central Ministries except those of Ministries of Defence, Railways and Irrigation & Power. The D.G.C. who will be the head of the Department of Construction will be responsible for advising the Minister on all matters pertaining to the Ministry in addition to rendering technical advice.
2. The DGC will be assisted by an Additional D.G.
3. In addition to the Addl. D.G. of Construction, the D.G.C. will be assisted by four Chiefs (*viz.*, Chief Engineer, Chief Surveyor of Works, Chief Architect and Chief of Utilities—Electrical, Mechanical and Public Health Engineering) and four Deputy Directors General each dealing with a particular branch *viz.* Finance, Planning Staff and Plant Machinery & Materials.
4. There will be a Central Design Branch under the Director General of Construction. This Branch will have four wings *viz.* Civil Engineering, Contract and Quantity Surveying, Architecture, and Utilities (Electrical, Mechanical and Public Health Engineering) under the Chief Engineer, the Chief Surveyor of Works, the Chief Architect and the Chief of Utilities, respectively. The Design Branch will prepare detailed designs and drawings for important projects besides acting as a consultative body for lower echelons, namely, DDsG (Zones) and DDsG (Projects) and the Construction Industry generally. It will be equipped with the best available technical talent in all disciplines of engineering with accent on specialisation.
5. The Finance Branch under a D.D.G. will advise the Ministry on all financial matters pertaining to works dealt with by the Ministry of Construction. The Branch will have separate sections to deal with expenditure, re-appropriation of funds, pay and allowances of staff and inter-departmental adjustment of funds.
6. The Planning Branch under the direction of a DDG will be responsible for maintaining liaison between the Construction Ministry and other Central Ministries. It will be associated with sponsoring Ministries in respect of works services aspects of various projects from the preliminary projects from the formulation stage till project is completed. The Branch will advise in the preparation of feasibility studies, detailed project reports, selection of sites, choice of specifications, etc. and be responsible for preparation of approximate estimates for works services. DDG (Planning) will be assisted by Directors, each Director dealing with a particular Ministry or a Group of Ministries. In addition, there will be a Director (Coordination), to coordinate the functions of various branches in the Ministry. Director (Coordination) will have under him separate sections dealing with policy, budget, procedures and regulations, norms information and publicity, and management. The Management Section will deal with programming of important projects and watch their progress till completion. Director (Coordination) will be responsible for obtaining up-to-date information about progress of various projects so that the DGC would be kept informed of it.
7. The Branch dealing with staff under a DDG will be responsible for all matters of personnel serving in the Ministry of Construction and in its lower echelons. The Branch will have separate sections for establishment, recruitment, Indian Service of Engineers, training, posting discipline and welfare, etc. Matters pertaining to the internal administration of the Ministry will come within the purview of this branch.
8. The Plant, Machinery & Materials Branch under a DDG will be responsible for planning' standardisation and procurement of construction plant and machinery. This Branch will also be responsible for assessment and development of building materials required by the Construction Industry and for Coordinating the functioning of various Building Materials Assessment & Development Cells in States. The Branch will lay down procedures for efficient utilisation of plant and for coordination of movement of plant from one project to another through Equipment Pools set up on a zonal basis and on commercial lines. Materials budgeting, conducting demand studies of manufactured building materials, procurement of materials and liaison with manufacturers will fall within the

purview of this Branch. The Branch will have separate sections dealing with Plant planning and standardisation, Plant procurement and movement and Materials assessment and development.

9. Works Services and Projects will be executed through Deputy Directors General (Zones) and Deputy Directors General (Projects). DDsG (Zones)/(Projects) will have full powers for carrying out works but will be guided by policies laid down by DGC. In case of Public Sector Undertakings, DDsG will be under administrative control of Managing Directors but will be guided by DGC in technical matters.
10. DDsG and Chiefs employed in the office of DGC, DDsG(Zones) and DDsG (Projects) will have the same status.
11. All Deputy Directors General and Chiefs will be given a suitable number of Directors depending upon the work load.
12. All Directors will have the same status irrespective of where they are posted.

